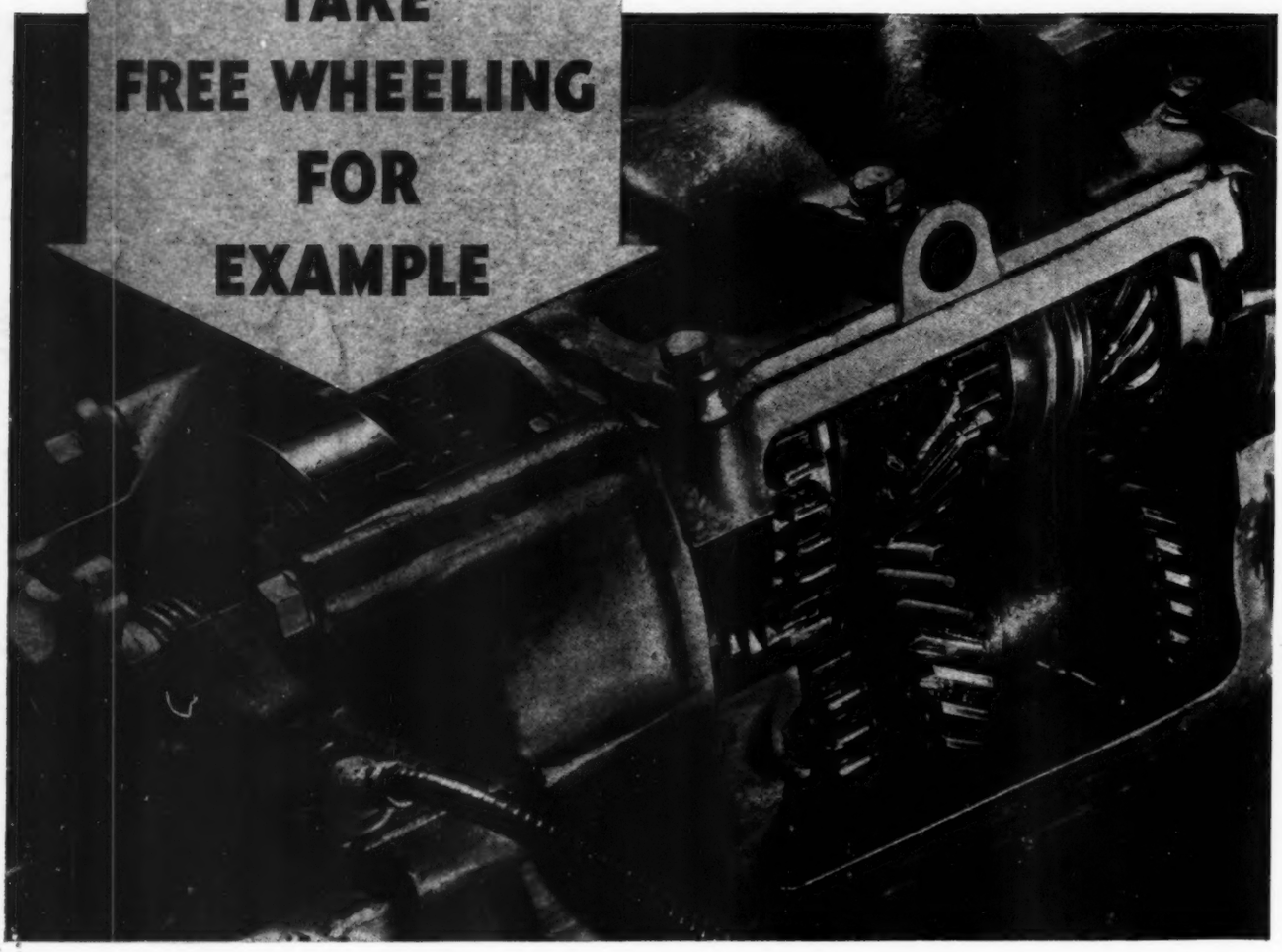
NEW INVENTIONS · MECHANICS · MONEY MAKING IDEAS
HOME WORKSHOP PLANS AND HINTS · 350 PICTURES

TAKE FREE WHEELING FOR EXAMPLE



Here is a free-wheeling gear set. A series of rollers forced into the narrow end of an eccentric raceway locks the engine and drive shafts. They are automatically released when coasting. It is a particularly exacting problem for lubrication.

There's one set of gears that demands a specialized lubricant of exactly the right viscosity. Too heavy—and the locking elements slip. Too light—disastrous wear occurs! Each car and each temperature range requires its special type of transmission oil. Texaco Certified Lubrication gives you the effective lubricant for every part.

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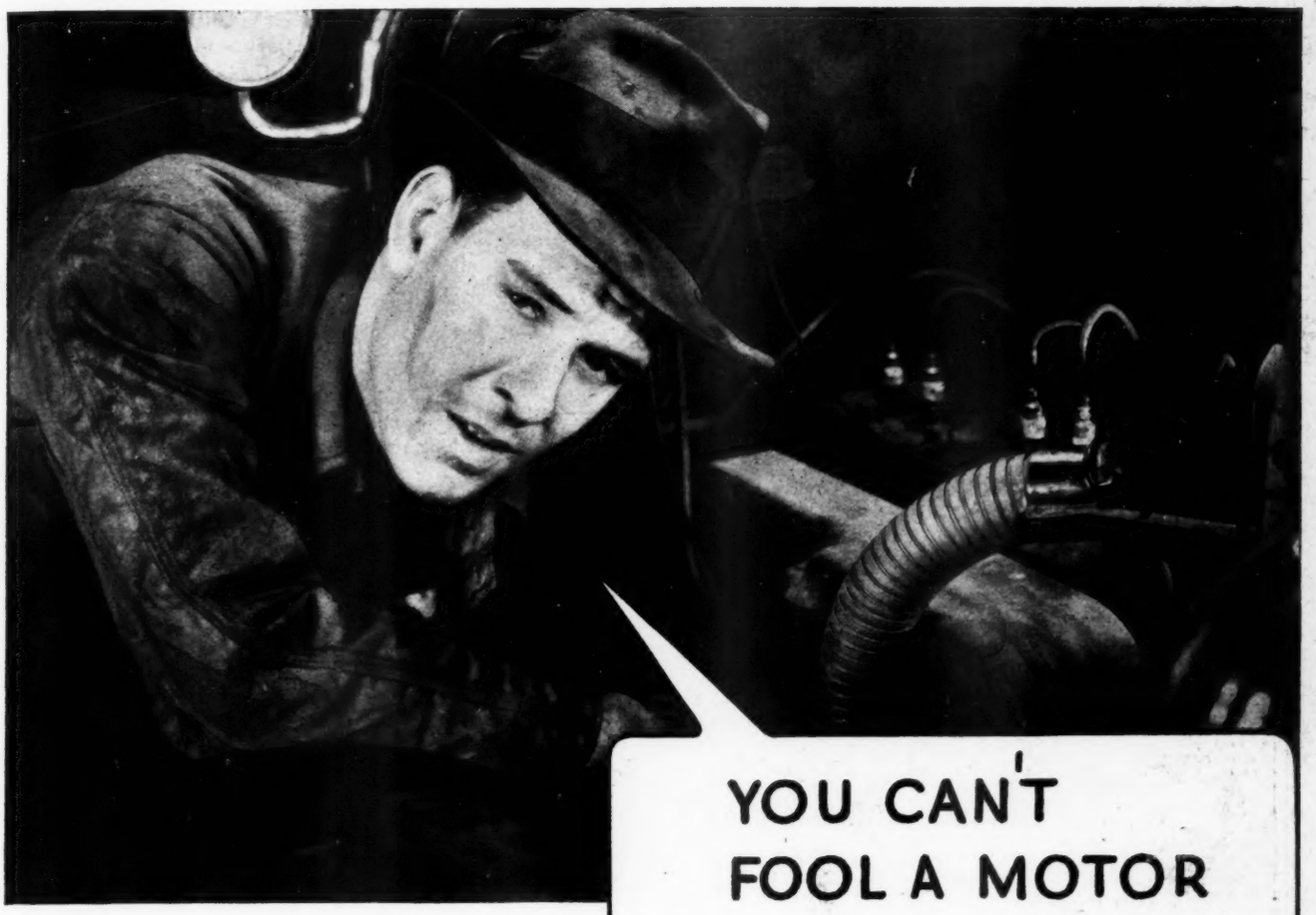
General Wahr



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"YOU TAKE the best car made and pour in cheap gasoline and what have you got? A half-hearted car, nine chances out of ten. No motor can be any better than the gasoline you feed it. That's why Ethyl makes *any* engine run better.

"I know what I'm talking about. A car doesn't know what you pay for gasoline and doesn't care. It just takes whatever kind of power you give it and hands you back that same kind of performance.

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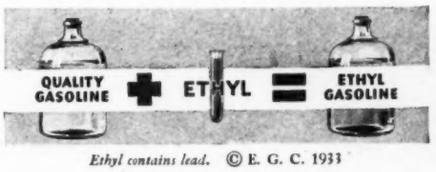

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THE WORLD'S HIGHEST QUALITY MOTOR FUEL

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POPULAR SCIENCE

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TELEPHONE LINES . . . putting her in instant two-way communication with a larger world—broadening her interests and extending her influence—rendering more simple the important business of managing a household. No item of home equipment contributes more to the security, the happiness and the efficiency of millions of women than the telephone.

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There are times when being "in touch" is vital, urgent . . . a sound in the night, a whiff of smoke, a sudden illness. There are times when the mere convenience of the telephone gives it an important place among life's necessities . . . to shop from your home, to chat with a friend, to handle, quickly and efficiently, the varied duties of a busy household. And there are times—many times daily—when the telephone is the indispensable right arm of business.

To make this possible, the Bell System provides millions of miles of wire and the services of an army of trained employees. They stand ready to answer your call; they offer you the service of a friend.

AMERICAN TELEPHONE AND TELEGRAPH COMPANY

POPULAR SCIENCE MONTHLY for JULY, 1933

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In This Issue—Hundreds of Fascinating Articles Tell the Latest News of Laboratory Discoveries, Scientific Triumphs, and Amazing New Inventions

Squandering our money at the BOOK-CADILLAC ... I raged

—until I found he paid only $2.50

"BOOK-CADILLAC" on the envelope was enough for me! I could picture my husband running up a whopping big bill at Detroit's "swankiest" hotel. And me at home longing for a new hat.

But when I read his letter, I was terribly ashamed of myself. Jack was having the time of his life—enjoying a room with private bath, circulating ice water—all the famous Book-Cadillac luxury—and it cost only $2.50 a day. I certainly couldn't crab at that!

Jack said, too, that the food was grand and not at all expensive. "Last night," he wrote, "I ate a delicious full-course dinner for 75c. All four of their restaurants are first rate. Splendid service in each."

Next time Jack goes to Detroit, I'm going to make him take me with him. It'll be a marvelous vacation, one that we can afford, too.

★ ★

1200 ROOMS . . . . $2.50 UP

HOTEL
Book-Cadillac
DETROIT

Directed by Ralph Hitz
J. E. Frawley, Manager

Hotel New Yorker, New York City, and Van Cleve, Dayton
Also under Ralph Hitz Direction

HOW TO GET STARTED IN THE HOBBY OF SHIP MODEL MAKING

BUILDING ship models is a hobby that costs very little. Few tools are required, the materials are inexpensive, and in the end you have something really worth while to show for the many hours of pleasant work you have put in. Thousands of POPULAR SCIENCE MONTHLY readers have found this true in spite of the fact that they had no previous knowledge of ships or of model making when they started to construct their first model from our plans.

Now, however, we have made it still easier to begin this hobby by providing construction kits of carefully selected materials. You no longer have to do a lot of "shopping around" to get what you want.

Two kits are especially recommended for beginners. One contains all the raw materials (except glue and paints) for building the beautiful model of the Elizabethan galleon *Revenge* illustrated on pages 66 and 85 of this issue. The kit is further described on page 78. Picturesque as this model is, the construction is not difficult. Do not be deceived by the costly and elaborate appearance of the finished model as it appears in the photographs mentioned. Capt. E. Armitage McCann, who designed it from original historic sources, kept in mind the needs of the beginner at every stage of the construction, and he used all the resources of his many years' experience to simplify the various details, including the rigging, to such a degree that the inexperienced model maker would find the work relatively easy. Each kit is accompanied by four blueprints showing all parts full size. These alone would cost $1 if purchased separately.

The second kit that has been designed chiefly for beginners contains the sawed-out hull and materials (except paints) for a 12 in. long miniature model of the new American liner *Manhattan*. It is illustrated on page 78. Because it is so very small and simple, the model can be made on the kitchen table—or in the living room, for that matter—with a pocketknife, a safety razor blade, a pair of small-nosed pliers, a file, and, if available, a fret saw or jeweler's saw.

Popular Science Homecraft Guild, 381 Fourth Ave., New York, N. Y.

☐ Materials for building a 25-in. long model of the galleon *Revenge*, for which I enclose $6.75 (or $7.25 with the hull blocks fully shaped)
☐ Materials for building a 12-in. miniature mode of the liner *Manhattan*, for which I enclose $1.00

Name .....

Address.....

City..... State.....
(Print very clearly)

Note: The *Revenge* kit is 50 cents higher west of the Mississippi River because of heavy shipping charges. If desired C. O. D., there will be an extra charge of 28 cents. The *Manhattan* kit is not sent C. O. D.

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keeps a SIMONIZED Car Clean and Bright

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And after you Simoniz your car, dust and dirt wipe off easily with a dry cloth. That's all there is to keeping it clean!

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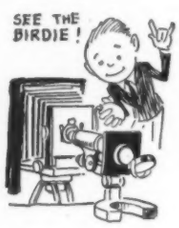
MOTORISTS WISE SIMONIZ

Our Readers Say

He Gets a Real Kick Out of His Photomicrography

YOUR article on making photomicrographs guided me in taking several such pictures in my cellar laboratory. Simple Cramer 4 by 5-inch contrast plates were used, giving a one half second exposure with the microscope condenser in place. The enlargement, when figured for eye observation, was 160 times linear. The differentiation on the finished picture between haematoxylin and eosin was perfect, the red eosin showing, naturally, as black. The nineteen pictures I have made serve to illustrate a paper on general histology prepared by a medical student. The slides I used were made by a laboratory assistant for rough general work and are so poor that in many cases it was impossible to get a sharp image all over the field. Such prints, however, can be divided and a sharp section selected. I have found much of interest in your recent issues.—J. B. M., Cincinnati, Ohio.



Glue Maker Has Some Real Inside Information

IN ANSWERING C. G. A., Corinne, Utah, I make the following suggestions about glue. The increase in volume depends upon the quality of the glue. Good glue should double its weight; bad glue will dissolve or become like jelly and cannot be removed whole from the water in which it is soaked. Glue should be soaked in one pound of water to each ounce of glue. Soak the glue from twelve to sixteen hours and then remove it to the pot without the addition of more water. Cook the glue about three hours at a temperature of ninety degrees F. Be careful that this temperature is not exceeded. If cooked too long it will turn brown and become brittle. To test glue for its quality, place five ounces of sheet glue in five pounds of water for twelve hours. If the glue is dissolved in this time it is no good. If it is coherent and weighs ten ounces, it is good.—A. R. C., Victoria, B. C.

He Learned About English From the Talking Pictures

FOUR years ago when I came to America from Germany, I knew practically no English. Instead of going to night school, I went to the talkies. For four weeks, I went every day, making out the sense of what was said from the action of the play. It taught me more English, as it is actually used in everyday conversation, than a year of schooling would have done. If anyone wants to learn English as she is spoke in a short time, let him go to the talkies.—A. H., New York City, N.Y.

Nifty Little Experiment With a Rusty Old Nail

IN ANSWER to S. B. M.'s letter in a recent issue, I suggest that he try the following experiment: Place a nail in a test tube of boiled water. Place another in a test tube of water as it comes from the faucet. After a time this second nail will rust while the first will not. This rusting, or oxidation, is due to the oxygen of the air that is dissolved in the water and not to the oxygen of the water in the combined state. The water acts only in the capacity of a catalytic agent.—N. C. T., Dayton, Ohio.

Coldwater Reader Seeks Information on Freezing

IN A recent issue of POPULAR SCIENCE MONTHLY, there was printed a picture of frost feathers frozen to a post on top of some mountain. Also it was said that an expedition was setting out to study this phenomenon. Frost feathers, I believe, are caused by the freezing of the slight amount of precipitation that takes place directly behind the post, due to moisture-laden air experiencing a sudden drop in temperature. The sudden drop in temperature is caused by the partial vacuum created directly behind the post. This slight vacuum is caused by the high-velocity wind blowing past an object that is not streamlined. If a perfectly streamlined post were erected and kept in line with the wind, no vacuum would be created behind it and no drop in temperature would occur to cause precipitation. Hence, no frost feathers would form. I am guessing, but the temperature of these winds on this mountain must be just about perfect for this to happen. I would guess thirty-two degrees or lower but close to thirty-two, unless the freezing point of water varies as does the boiling point due to water being under different pressures. If that is the case the temperature would be a little higher. That makes a good question for "Our Readers Say." Does water freeze at thirty-two degrees regardless of whether it is subject to a vacuum or a pressure? The boiling point varies. Why shouldn't the freezing point?—C. P. S., Coldwater, N. Y.

Maybe This Reader Has Made a Discovery

FOR four years I've been reading POPULAR SCIENCE MONTHLY without a cheep. Now, that I'm out of my eggshell and fully grown, I'm here with a big laugh, having read Big Ship Adds No Weight to Bottom of Canal Lock. I dispute this statement, inasmuch as nothing was said of the ship forcing its weight in water over the sides of the canal. In other words, if the displaced water still remains in the canal, the presence of the big ship certainly does add weight to the canal lock bottom. How about it, readers? Is my gray matter centered or off? At any rate, Mr. Editor, keep up the good work. (No irony intended.) And when convenient, give me the latest in psychology.—J. L. V., Buckingham, Ia.

Shoot the Chutes for Life From a Burning Building

I NOTICED an item in the paper the other day which told of many lives being saved in a Tokio fire by canvas chutes which were thrown from upper story windows and down which customers slid to safety. Here is an idea that ought to be applied to American skyscrapers. Fire ladders can reach only so high and a person can jump into a fire net only from the lower stories of a big building. Why not have all upper stories of a skyscraper equipped with these canvas chutes which in an emergency can be thrown to buildings across the street and secured several stories down? Then people, trapped in the burning structure, could slide down the canvas strips to the other buildings and escape.—A. R., Newark, N. J.

Your Ferris Wheel Bug Must Be Getting Dizzy

IN ANSWER to J. W., Brinkley, Ark., let me state that there are two velocities represented by the Ferris wheel. One is called angular velocity and is measured in revolutions per unit of time. The other is linear velocity and is measured in feet, yards, or miles per unit of time. If he is computing velocities according to the first method, their speeds are identical, but if he uses the second method, the difference in speed will depend on the Ferris wheel's radius.—R. H. S., Bethany, W. Va.

But Who Can Tell Us Where Niagara Started?

HERE is one for the wise boys: What fools we are to swallow everything that comes along. For instance, if the earth were as old as some of our wise men claim, there would now be no Niagara Falls. Long ago, it would have eaten its way back to Lake Erie. It is now retreating at more than a foot a year, but at that rate it would retreat, in a million years, over 189 miles. And where would it be then? Here's another: The south polar continent, in so long a time, would have become top-heavy with ice and its weight would turn the earth upside down. Also, the earth is young by comparison with other planets. If evolution is active on them why has it not gone so far

there that more advanced forms of life might have been carried to our earth?—J. W. C., David City, Nebr.

Earthquake as War Weapon Is a Brand-New Idea

ARE we overlooking a possible war terror of the future? I'm thinking of synthetic earthquakes that might be employed to wreck whole cities. Suppose a thousand tons of high explosive were planted as a mine and touched off. That's not at all inconceivable; a quarry blast one fifth as large was set off in Michigan a year ago. It jarred seismographs in twenty states. Now suppose a way could be found to focus the earthquake waves toward a definite objective, instead of allowing them to spread indiscriminately in all directions; say, by the use of a deep-sunk concrete reflector of parabolic shape, or some other mechanically simple device. What would happen to a city at which the earthquake wave was aimed? I think the recent earthquake catastrophe in California gives us a good idea of the answer.—P. C. G., Portland, Ore.

Will Anything Dissolve Hot Water Sediment?

COULD one of your wise readers kindly tell me what can be used to dissolve the sediment left after hard water has been boiled? Or is there anything that will dissolve it? I think you have a wonderful magazine and as far as improvements are concerned I think there is practically nothing you can do to improve it.—L. D. J., Rivermines, Mo.

Raising Tropical Fish Described in June Issue

I'M INTERESTED in aquariums, as are several of my friends, and we have formed an association in this city and would be more than grateful if a corner of the magazine could be devoted to the building of aquariums, tropical toy fish, their habits, feeding, etc. I know that America is a likely place to get information on this subject as it seems a popular hobby over there. However I leave it to the popularity of Our Readers Say columns to decide whether or no we are to have a corner in the magazine for this interesting hobby. We have to pay two shillings a copy for our POPULAR SCIENCE MONTHLY and would pay three times that amount.—F. W. G., Pretoria, South Africa.

Not a Pipe Dream But There's Smoke in It

THE fact that smokes rise is something you will grant as correct. If you can show that smoke will go down instead of up, people will admit you have done something remarkable. All you need to accomplish this is the cellophane wrapping that comes around a cigar. Take this little tube, hold it upright, and set fire to the top of it. As a result, you will see the smoke going down the tube instead of rising. As the flame burns downward more smoke will form and sink below the flame. Why is this?—M. K., Cleveland, Ohio.

This Fresh-Water Diver Made His Own Helmet

I SAW in a recent issue that you wanted a letter from someone who had used a shallow-water diving helmet. I made such a helmet two years ago and am still using it. I live on the Black Warrior River and have raised motorboats and other valuable things from the water at a depth of thirty-five feet. In the current of the river, we drop an anchor and hold to the rope. If the rope is turned loose, the diver is washed away from his helmet. The only disadvantage in diving is the inability to take much health-giving exercise.—H. C., Tuscaloosa, Ala.

What! More Aviation?

WHY not have more aviation? After all, isn't aviation a science? It is the most promising industry there is. Let's hear more about famous men like Hawks, Byrd, Doolittle, and Stainforth.—W. R., Scarsdale, N. Y.

Is this Merely a Slam at The Heroic Babe Ruth?

RECENTLY a thousand people answered a questionnaire on the worth of prominent men. According to 140 of them, Babe Ruth is the only man in the world worth an $80,000-a-year salary. Only the President of the United States, said 185, should get that amount and 572, more than half, declared that nobody was worth that much money. What about the scientists? Nobody mentioned them. How much a year was Edison worth to the world? Or Marconi, or Lister, or Bell or Pasteur? Nobody knows. My guess is that if they had been paid a million dollars a year during the time they were giving us the electric light, the telephone, the radio, antiseptics, and antitoxins, they would not have received a penny too much!—J. D. T., Baltimore, Md.

Here's a Gigantic "If"

COULD some physicist please answer me this one? If it were possible to make a container of some substance that would neither expand nor break, and fill it with water, could the water be frozen?—M. S., Neoga, Ill.

What Next? This Man Wants Us To Start An Art School

HERE'S a humble wish of my own which you may disregard without offending me very much. I should like to see an article dealing with the fundamental elements of perspective drawing. Or doesn't it come under the head of science? I should like to learn to make freehand drawings of buildings, etc., without going into an elaborate system of projections and traces. The simpler the method, the better it would suit me.—G. A. K., Ironwood, Mich.

We Have Printed "A, B, C" Articles on Both Subjects

I AGREE with J. A. McA., of Covington, Va. I like the radio stuff, but no magazine or textbook handles the subject in simple enough terms for some of us dumbbells to sabe. When they try, they quit the simplicity part right at the wrong time. A few short sentences in each issue, running in serial form, and starting out with the A, B, C of the principles would make your magazine a lifesaver for a lot of us. A similar series on photography, starting from the simplest things about it and continued for a good long time, giving plenty of examples, would be of still more help to a good many of us.—A. L. S., Helper, Utah.

Hind-Leg-First Mosquitos Prove Unwelcome Guests

WHAT America really needs right now is a window screen through which mosquitos cannot crawl as they do through the screens now in use. I have seen a dozen or more of the pests getting in during the night, in spite of a sixteen-inch mesh. Reliable investigators have told me that the blood-thirtsy creatures crawl in with the hind legs first. While some one is devising a satisfactory screen, he might at the same time compound a putty with which to mend chipped enamel dishes. It should be able to withstand heat and cold. If it is made white, it must remain so.—S. G., Lincoln Park, Mich.

Knockers Have Their Place In the Scheme of Things

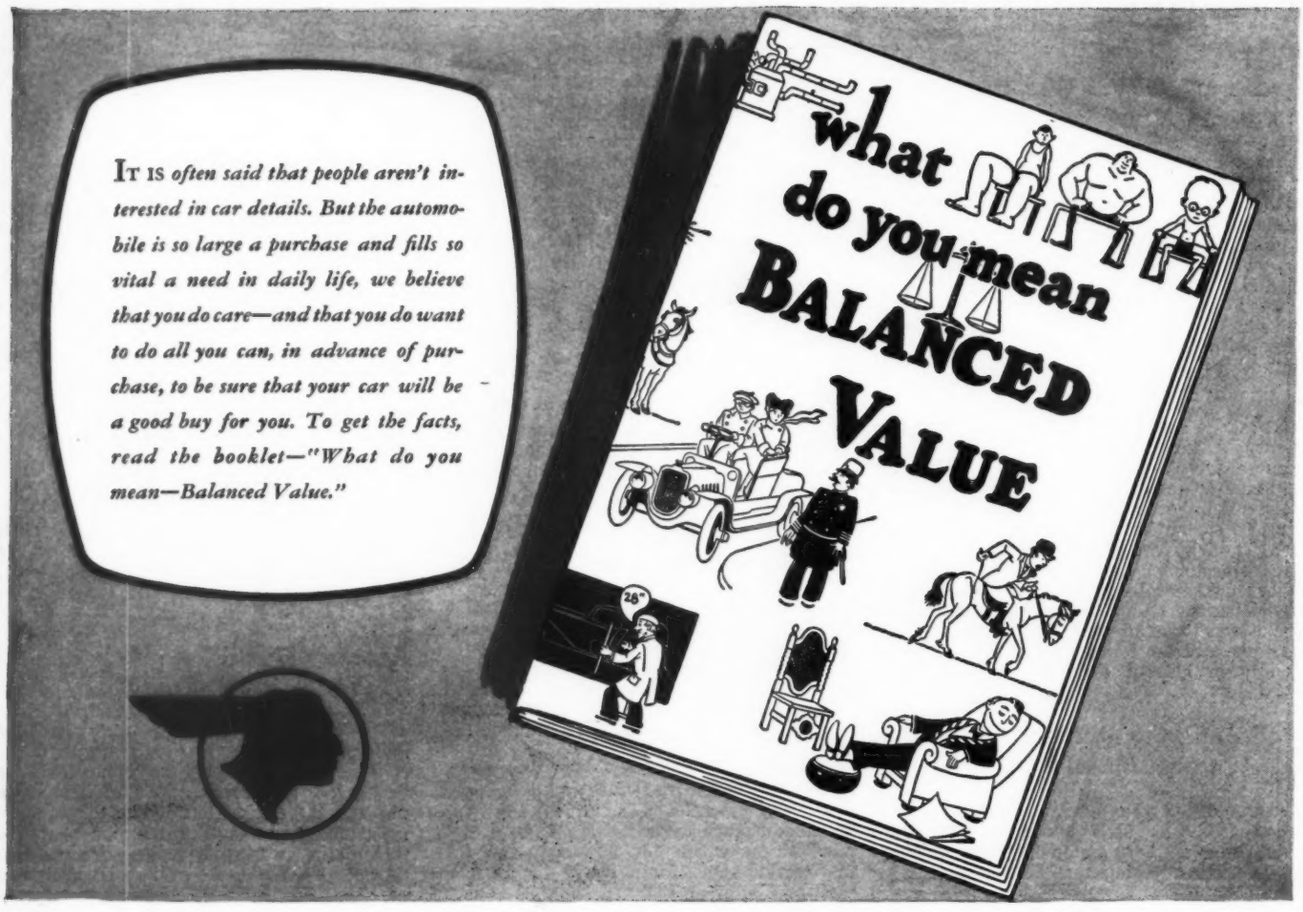
DON'T pay any heed to these so-called knockers who write in to Our Readers Say column. They don't know when they are well off. I find every article of interest to me, and those who do not like this or that, must indeed be very narrow-minded, or else their desire to learn is so very limited that they do not understand that which they do not like. My only objection is that there is not enough of anything. I would suggest, if asked, that you double the thickness of the magazine, with similar facts of interest and, if necessary, double the price. I for one would be more than glad to pay the difference as there is not enough to last between issues.—K. D. R., Elizabeth, N. J.

His Scientific Interest Invades Electric Chair

THERE is one thing I should like to ask of you: Will you please publish an article, with pictures, about the far-famed electric chair. I'm sure if more criminals knew exactly how it works, they would be a little more timid about killing folks. On these grounds, the authorities ought to be very grateful to you. I am sure many other readers will back me up in wanting to see pictures of these chairs, but not from the murderer's point of view.—J. G. C., Toronto, Can.

Water Freezes, Ice Floats, And They Weigh the Same

HERE is a crazy problem that's been bothering me for a long time and I'm turning to your readers for an answer. We all know that ice floats in water with some of its surface exposed. Yet, if we pour a pound of water into a pail and let it freeze we will get a pound of ice. But here's the catch: if a pound of water freezes to form a pound of ice, how does it happen that ice floats in water? Something is flooey with my reasoning or else the laws of physics are wrong—and I'm a great believer in the everlasting laws of nature.—L. W. B., Kingston, Wis.


It is often said that people aren't interested in car details. But the automobile is so large a purchase and fills so vital a need in daily life, we believe that you do care—and that you do want to do all you can, in advance of purchase, to be sure that your car will be a good buy for you. To get the facts, read the booklet—"What do you mean—Balanced Value."
what do you mean BALANCED VALUE

Here is a booklet you ought to read (*it is free*)

Perhaps the sincerest wish of a man is that his new car will be durable and dependable. He hopes that the thrill he got when he bought it will turn into lasting satisfaction. Which is simply another way of saying that he hopes it will be economical.

In the past, he feels, he has sometimes been lucky—sometimes unlucky.

What can he do to be sure, in advance, that his car will stay new long enough to be a good buy for him? He knows he can get out of the car only what has been built into it. So he wants to know what is in it—what his expectations may be.

Now it is reasonable, isn't it, to say that because Pontiac is the car of Balanced Design it gives the owner Balanced Value? The latter is really the necessary result of the former.

What this means and what it does for the owner are explained in the booklet—"What do you mean—Balanced Value." It is worth reading, we believe, because it will make you a better car buyer—a better judge of value.

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Ask any Pontiac dealer and he will gladly give you a copy. Or, if you prefer, use the coupon, or send a postcard, and we will mail you a copy. The book is Free.

POPULAR SCIENCE
MONTHLY
July 1933 Vol. 123, No. 1
RAYMOND J. BROWN, Editor
FOUNDED 1872
SIXTY-SECOND YEAR

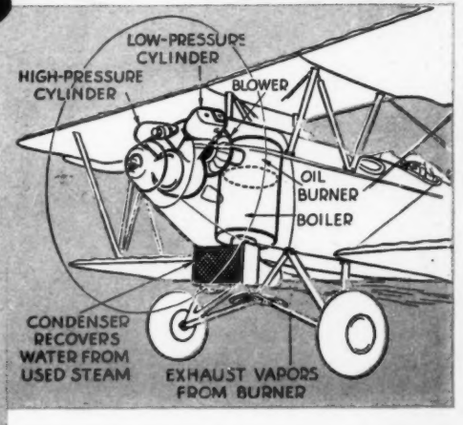
WORLD'S FIRST Steam-Driven Airplane

Successful Flights with Long-Sought Craft Crown Many Similar Attempts by Early Aviation Engineers

By H. J. FitzGerald

OVER the Oakland, Calif., Airport, a few days ago, a silent plane slanted across the sky trailing a thin ribbon of white vapor. Spectators heard the pilot shout a greeting from the air. They saw him flash past, skimming the ground at a hundred miles an hour. They watched him bank into a turn, slide to a landing, and, with the propeller spinning backward, roll to a stop in less than a hundred feet. They had seen, for the first time in history, a man fly on wings powered by steam!

Two brothers, George and William Besler, the former a geologist thirty-one years old, and the latter a mechanical engineer, two years younger, have achieved the dream of Maxim, Langley, and other pioneers of flight. Through their work, the steam-driven airplane, long talked about, long planned, has become a reality.



Drawing shows the arrangement of the V-type engine in the nose of the Besler plane. All parts of power plant are ahead of the cockpit. At top, steam-driven plane in first flight with William Besler at controls

George Besler, left, with his brother William, inventors of the first successful steam engine for planes, are shown with their plane in which position of special boiler is seen

This spectacular development in the field of aeronautics is the result of three years of secret experiment. The inventors began their work in 1930, in a machine shop at Emeryville, Calif. A few weeks ago, they brought the product of their researches, a 180-pound engine developing 150 horsepower, to the Oakland Airport and installed it at the nose of a conventional Travel Air biplane.

This blue machine, with William Besler at the controls, sped down the runway and climbed into the air without a sound except the low whine of the propeller and the hum of wind through the wires. Swing-

Here is the first plane in the world's history to be flown powered by a steam engine. It is shown before the take-off enveloped in its own steam

ing back over the field at 200 feet, the pilot shouted "Hello!" and heard the answering calls from spectators below. Conversation in the craft, the two inventors told me when I interviewed them a few hours after their historic demonstrations, was as easy as conversation in an open automobile.

Three times, the blue plane blazed a steam trail into the air, taking off, landing, circling about, remaining aloft for five minutes at a time. The constant, wearing vibration of the gas engine was gone; the smooth push and pull of steam power had supplanted it. Each time, as the machine swooped down and the wheels touched, Besler pulled back a small lever at the side of the cockpit and the steam engine at the nose of the ship instantly raced in reverse, whirling the propeller backward to act as a powerful brake and reduce the landing run to a minimum.

This method of slowing down, possible only with steam power plants, applies the braking effect above the center of gravity and thus prevents nosing over in a quick stop. When wheel brakes are jammed on suddenly, a plane noses over or somer-

This is the engine, designed and built by the Beslers, that powers the steam-driven plane. It has met successfully its initial tests in the air

saults in a ground crash. Coming in at fifty miles an hour, the Beslers told me, the new steam plane can sit down and come to a stop in a field hardly a hundred feet square.

The engine is a two-cylinder, compound, double-acting, V-type power plant. Its high-pressure cylinder has a three-inch bore and a three-inch stroke; its low-pressure cylinder has five and a quarter-inch bore and a three-inch stroke.

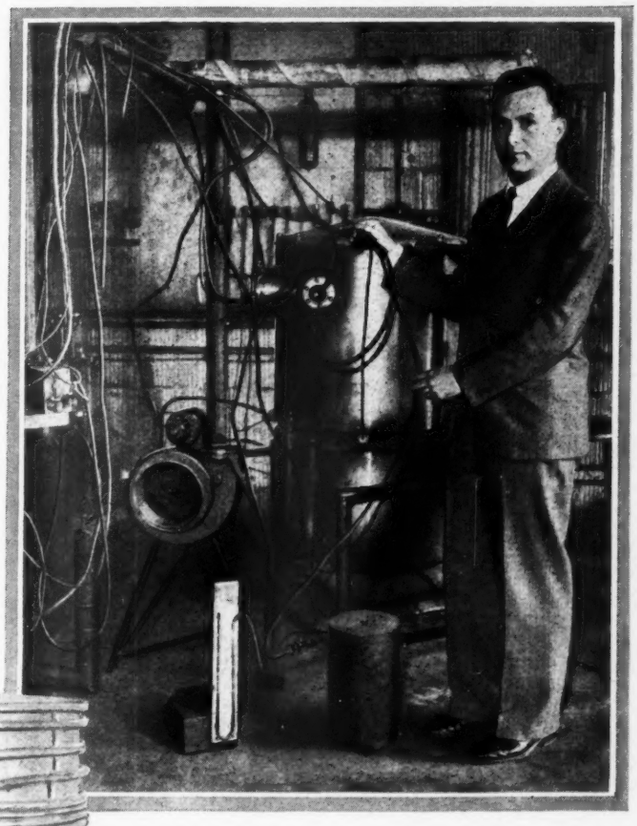
Just behind the engine, the inventors showed me the barrel-shaped metal boiler which, with its super-efficient burner, explains why they have succeeded where others have failed in attempting to drive planes with a steam engine.

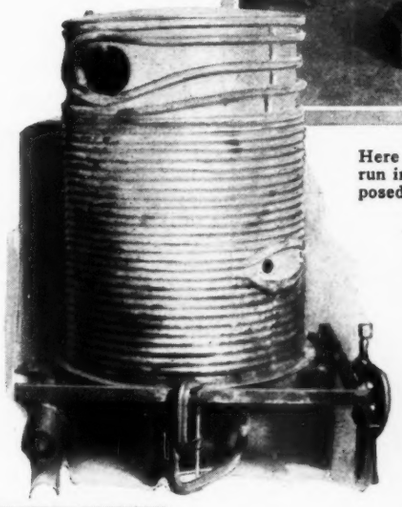
Using vaporized fuel oil, the patented burner releases as much as 3,000,000 British thermal units per cubic foot of fire-box space. This, they told me, is far in excess of anything hitherto attained. An electric blower drives this tremendous heat down among the flat spirals of a single 500-foot pipe coiled within the boiler. Three-eighths of an inch thick, inside measurement, at the bottom, the pipe gradually increases in size until it has an inside diameter of five-eighths of an inch at the top. The water supply to the coiled pipe is thermostatically controlled to keep the temperature constant regardless of pressure.

UNDER the fuselage nose is the condenser which looks like an ordinary radiator for a water-cooled motor and which is said to recover more than ninety percent of the water from the used steam. By using a steam-feed water-pump, the inventors employ the exhaust vapor to pre-heat the feed water entering the boiler and thus decrease the time required to build up pressure within the coils.

The operation of the power plant, once it is started, is practically automatic. At the start of a flight, William Besler climbs into the cockpit and flips over a small switch. Instantly the electric blower goes into action, driving air mixed with oil spray through the burner. Here, an electric spark ignites the mixture and sends a blowtorch of flame roaring downward around the coils of pipe. A few minutes later, steam pressure is high enough for the take-off. All the pilot has to do, from then on, is to operate the throttle and reverse lever.

At 800 degrees F., the steam pressure built up within the coils reaches 1,500 pounds. With a 1,200-pound pressure, the engine will deliver 150 horsepower, whirling the propeller at 1,625 revolutions a minute. Tests have shown that ten gallons of water is sufficient for a flight of 400 miles. By increasing the size and efficiency of the condenser, the experimenters told me, they believe they can make this amount of water last indefinitely.





Here is William Besler preparing power plant for test run in workshop. At left, the interior of the boiler exposed to show coiled pipe used in generating steam

As news of their sensational flights flashed to all parts of the country, eager interest was aroused among aeronautical authorities. The prospect of steam planes on the skyways opens up fascinating possibilities.

Burning fuel oil so non-explosive that it merely smolders if struck by the flame of a blowtorch, the new power plant eliminates the menace of fire. In addition, the Beslers told me, enough fuel oil for a hundred-mile trip can be bought for forty cents.

Because, above a thousand feet, steam-driven planes would be as silent as soaring birds, they would have particular value in military work. Noiseless war planes have long been sought. But muffling gasoline engines reduces their power to such an extent that the plan is impractical. The new power plant, silent by nature, would permit long-distance raids above the clouds by ghost ships giving off no telltale drone of motors to warn the enemy or to aid in directing anti-aircraft fire.

This picture was made when, for the first time in the world's history, a steam-driven plane successfully flew with a man at the controls

MOST spectacular of all are the possibilities of steam on the airways of the stratosphere. In the thin atmosphere of this region, ten miles or more above the surface of the earth, experts agree, the highspeed transport ships of the future will fly. Here there are no clouds, no storms, and the steady trade winds of the upper blue will increase the speed of long distance passenger, mail, and freight machines.

Already, here and abroad, stratosphere ships, with pressure cabins and variable-pitch propellers, have been designed and are under construction. Test hops have been made in such high-flying experimental craft in France and Germany. The chief stumbling block at present is the gasoline motor. It steadily loses power as it ascends. Climb to 20,000 feet and a motor that delivers 150 horsepower at sea level will retain only half its power. Spiral on up to 30,000 feet and your engine will have but three-tenths of its sea-level horsepower. And you are then only half way to the stratosphere! *(Continued on page 92)*

BOY RIDES TOY SEAPLANE POWERED BY GASOLINE MOTOR

Model seaplane, driven by midget gasoline motor, skims across water. Right, the plane with wings folded and loaded on trailer

DOING everything but fly, a model seaplane provides aquatic sport for the young son of a British craftsman, who made the machine in his own workshop. The craft skims across the water on its pontoons at a speed of about twelve miles an hour, under the power of a midget gasoline motor and an air propeller. When it is ready to be taken home, the wings, too small actually to lift it from the water, fold up and the machine is set on a convenient trailer to be towed away behind a car.

FIFTH WHEEL MAKES TIRE TESTS SAFE

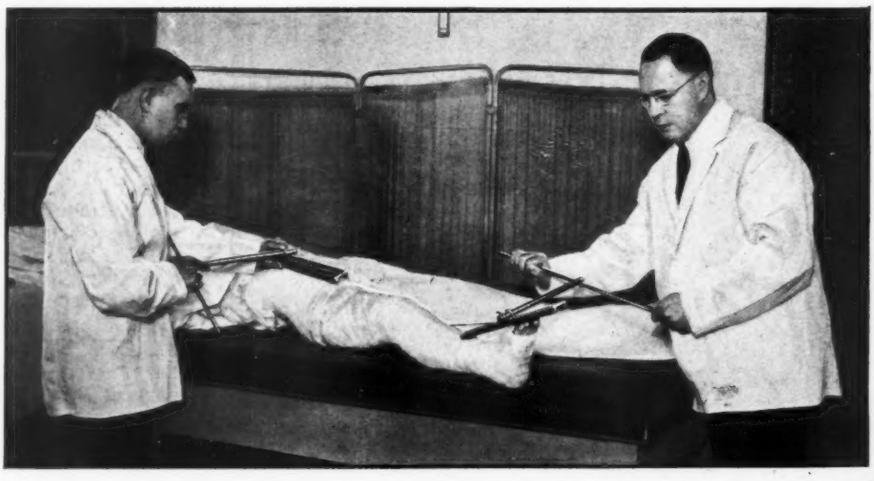
SEEKING a blowout-proof racing tire, a manufacturer recently staged high-speed road trials on the Indianapolis Speedway. Samples of tires to be tested were placed, one after another, on the right rear wheel of a racing car—usually the first to show wear on this course because of its counter-clockwise turns. Drivers kept the car running until each test tire failed. To protect the driver's life, a fifth wheel was added as shown at left. When a tire blew out, the car simply dropped safely on its fifth wheel.

WALLBOARD INSULATED WITH ALUMINUM SHEATH

ALUMINUM, covering one side of a new wallboard, is expected to improve its heat-insulating quality. The polished metal stops summer heat by reflecting it back as a mirror does light, while in winter it diminishes heat loss by radiation. The metal sheath has been partially detached, in the photograph above, to show core of gypsum board.

WIRES SLICE OFF PLASTER CAST WITHOUT HURTING PATIENT

WHEN his wife had to be put in a plaster cast following an automobile injury, W. K. Kearsley, research engineer of Schenectady, N. Y., received permission from a doctor to try out a new way of removing such a cast. He had been informed that this was a necessarily trying task, requiring the cast to be softened with vinegar and then chipped or cut away with heavy cutting pliers or saws. At his suggestion, lengths of flexible wire were placed beneath the cast when it was applied. Weeks later, at the time for its removal, Kearsley attached the projecting ends of the wires to a small appliance like a windlass that he had devised. When it was wound up, the wires sliced neatly through the plaster, which then dropped away without disturbing the patient. The invention, adopted by a Schenectady hospital, may come into general use.

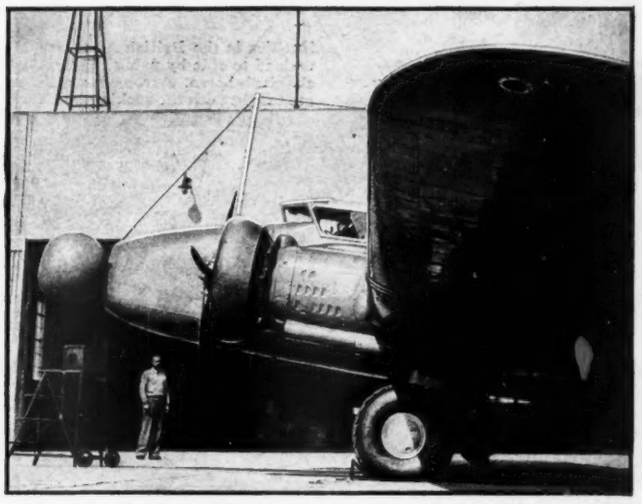


The view of Krakatoa, left, in full eruption, was taken by daring flyers in an airplane as shown in lower picture. Lava burned the plane's wings as it skimmed the crater's edge

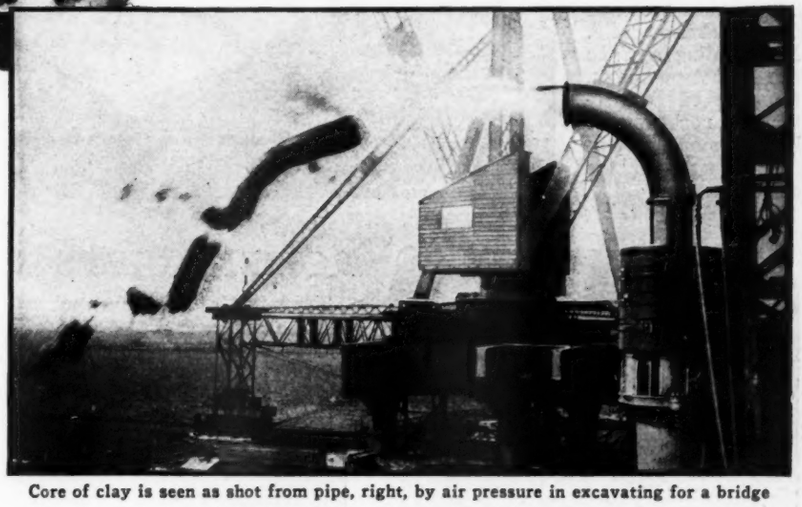
TAKE PICTURES OF VOLCANO AS LAVA SCORCHES PLANE

SKIMMING so close that molten lava spattered the wings of their plane, a daring pilot and photographer risked their lives, not long ago, to make close-up pictures of the East Indian island volcano Krakatoa in full eruption. While other cameramen were content to remain at a safe distance in a boat, these two flyers, repeatedly banking their craft in the nick of time to escape the fiery column, obtained fine views of the outburst, which continued with unabated fury for forty-eight hours. The recent eruption occurred just fifty years after one of the most violent in the world's history—the explosion of Krakatoa that blew off its top and caused tidal waves that drowned 30,000 persons.

MAIL IN PLANE'S FALSE NOSE



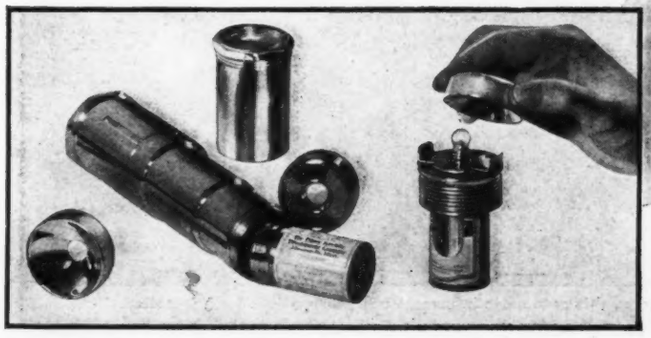
THOUGH it looks as if it carried a balloon at its nose, the airplane pictured above actually owes its odd appearance to an innovation in the arrangement of cargo space. To give the ten passengers more room in the cabin, the mail compartment is placed at the forward end of the fuselage, ahead of the pilot and propellers. A curved door at the extreme front, which is seen swung open on its hinges in the picture, provides access for loading and unloading. More than half a ton of air mail may be carried in the new cargo space.

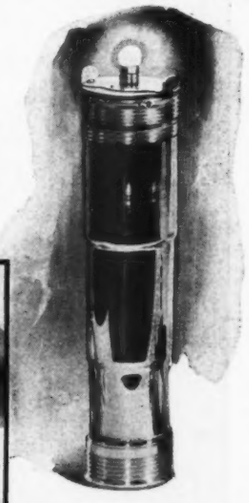


Core of clay is seen as shot from pipe, right, by air pressure in excavating for a bridge

FLASHLIGHT IS A TELESCOPE

MANY useful implements for campers and hikers are combined in a new convertible flashlight. By rearranging its parts, it is readily transformed into a telescope, a candle lamp, a magnifying glass, or a burning glass. The case contains a waterproof first-aid kit in addition to two standard dry cells. Despite its many adaptations, the nickel-plated case, when completely assembled, measures less than ten inches in length.





The candle lamp, above, is one of many uses of the flashlight seen at left

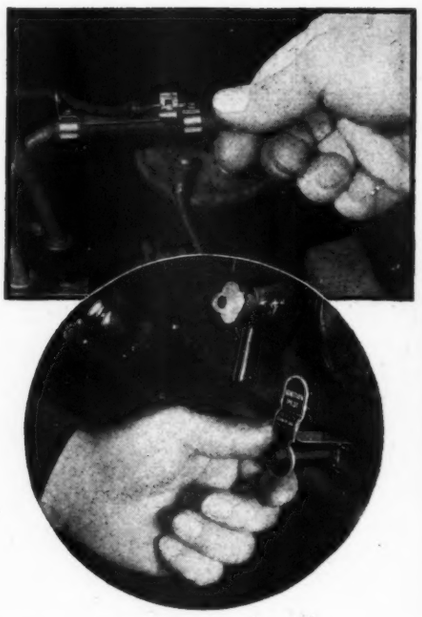
BRIDGE FOUNDATION DUG WITH COMPRESSED AIR

HUGE "sausages" of clay, weighing as much as three tons apiece, are hurled to the surface from subterranean depths by compressed air, in a new method of excavating for bridge foundations. A steel cylinder, four feet in diameter, with a cutting edge on the bottom, is first sunk in the ground. When it is in place, compressed air, at a pressure of 120 pounds to the square inch, is forced in at the bottom of the cylinder. The solid plug of clay in the pipe is hurled from its upper end at a speed of 100 miles an hour. The new method is reported to reduce the need for sending men underground to work under uncomfortably high air pressure and also to shorten greatly the time generally required for this work. The workmen, it is said, are in little danger of injury or death when using the air-pressure method and as a result it is expected that this process will gain favor among contractors.

ROCKING-HORSE TRAINS BRITISH RIDERS

Rookies in the British Army are trained to ride by using this mechanical horse. Acrobatics also are taught with the rocking-horse

MOUNTED on rocking-horses, recruits of the British cavalry are now receiving preliminary training in horsemanship. At the Army Equestrian School, at Weedon, England, the wooden horses were recently installed to give rookies the feel of the saddle and practice in mounting and dismounting before they tackle the spirited animals stabled at the school. In advanced horsemanship, the wooden horses are also employed in teaching acrobatics and trick riding. They are said to be especially useful in helping riders acquire the right balance when a horse takes a hurdle. Dismounting from one of the rocking-horses, by means of the spectacular neck-roll, is being demonstrated in the photograph by the chief instructor.



NEW AUTO LIGHT WARNS OF IGNITION TROUBLE

A NEW pilot lamp, attached to a car's dashboard by a screw bracket, warns a motorist instantly of any trouble in the ignition system. So long as the coil and spark plugs are working properly, the window of the indicator, illustrated in circle, is illuminated by a red neon light. No direct electrical connection to the car's wiring is needed; a device known as a condenser pick-up is clipped to the wire between coil and distributor (upper photo) without removing the insulation.

EAR TUBES FOR PHONE MAKE WORDS DISTINCT

PERSONS hard of hearing, who have difficulty in carrying on a telephone conversation, are said to be aided by the new set illustrated above. When answering a call, the user places a receiver of conventional design (at right of photo) upon the base of an instrument resembling a physicians's stethoscope. Tubes lead to a pair of earpieces that help to make every word audible. In speaking, the special transmitter, seen in background, is used.

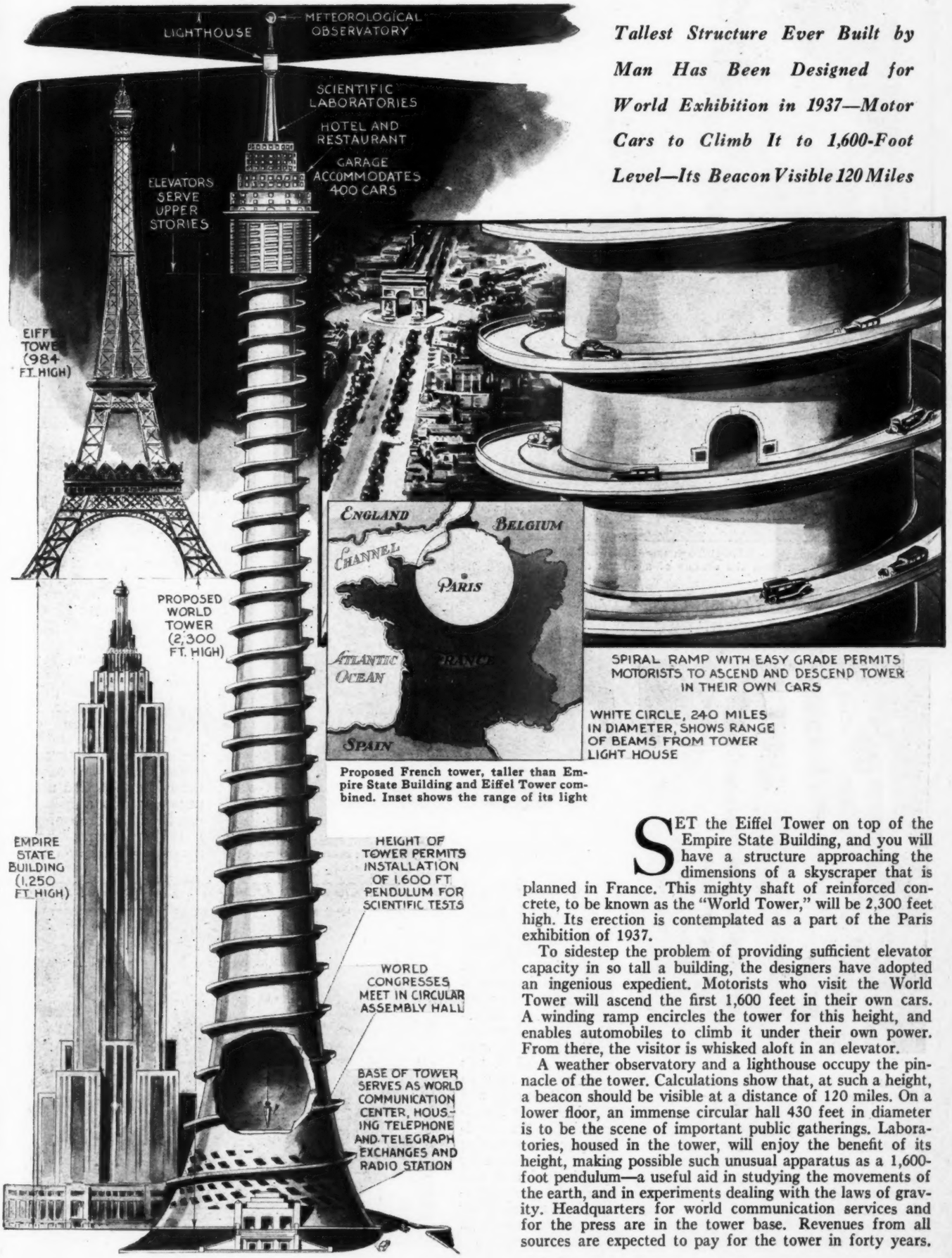
ROBOT GUIDES SUBWAY RIDER IN LONDON

TWIRLING a dial helps subway riders find their way, at a self-service information booth just opened in London, England. To inquire how to reach any point in the city, the traveler sets the dial according to a printed list of instructions. The device then informs him of the place's location, the exact fare required, and the number of the platform from which the appropriate train leaves.

In the subway of London, this automatic information booth has just been installed. From it the travelers can learn, by working the dial, location of a desired spot and how best to reach it

Paris Plans 2,300-Foot Tower

Tallest Structure Ever Built by Man Has Been Designed for World Exhibition in 1937—Motor Cars to Climb It to 1,600-Foot Level—Its Beacon Visible 120 Miles


LIGHTHOUSE
METEOROLOGICAL OBSERVATORY
SCIENTIFIC LABORATORIES
HOTEL AND RESTAURANT
GARAGE ACCOMMODATES 400 CARS
ELEVATORS SERVE UPPER STORIES
EIFFEL TOWER (984 FT. HIGH)
PROPOSED WORLD TOWER (2,300 FT. HIGH)
EMPIRE STATE BUILDING (1,250 FT. HIGH)
HEIGHT OF TOWER PERMITS INSTALLATION OF 1,600 FT. PENDULUM FOR SCIENTIFIC TESTS
WORLD CONGRESSES MEET IN CIRCULAR ASSEMBLY HALL
BASE OF TOWER SERVES AS WORLD COMMUNICATION CENTER, HOUSING TELEPHONE AND TELEGRAPH EXCHANGES AND RADIO STATION
ENGLAND
BELGIUM
CHANNEL
PARIS
ATLANTIC OCEAN
FRANCE
SPAIN
SPIRAL RAMP WITH EASY GRADE PERMITS MOTORISTS TO ASCEND AND DESCEND TOWER IN THEIR OWN CARS
WHITE CIRCLE, 240 MILES IN DIAMETER, SHOWS RANGE OF BEAMS FROM TOWER LIGHT HOUSE

Proposed French tower, taller than Empire State Building and Eiffel Tower combined. Inset shows the range of its light

SET the Eiffel Tower on top of the Empire State Building, and you will have a structure approaching the dimensions of a skyscraper that is planned in France. This mighty shaft of reinforced concrete, to be known as the "World Tower," will be 2,300 feet high. Its erection is contemplated as a part of the Paris exhibition of 1937.

To sidestep the problem of providing sufficient elevator capacity in so tall a building, the designers have adopted an ingenious expedient. Motorists who visit the World Tower will ascend the first 1,600 feet in their own cars. A winding ramp encircles the tower for this height, and enables automobiles to climb it under their own power. From there, the visitor is whisked aloft in an elevator.

A weather observatory and a lighthouse occupy the pinnacle of the tower. Calculations show that, at such a height, a beacon should be visible at a distance of 120 miles. On a lower floor, an immense circular hall 430 feet in diameter is to be the scene of important public gatherings. Laboratories, housed in the tower, will enjoy the benefit of its height, making possible such unusual apparatus as a 1,600-foot pendulum—a useful aid in studying the movements of the earth, and in experiments dealing with the laws of gravity. Headquarters for world communication services and for the press are in the tower base. Revenues from all sources are expected to pay for the tower in forty years.

Drives Midget Car Right Through Doorway

This car, small enough to drive through the doorway of a house, was fashioned from the chassis of a midget auto

WHEN he reaches the scene of an indoor spraying job, one British contractor does not leave his car parked outside, but drives right in through the doorway! His midget auto was fashioned from the chassis of a standard make of small car, which was remodeled to even more diminutive size so that it would pass through an aperture only twenty-eight inches wide. Spraying apparatus is mounted on the rear, and the operator moves it about indoors with the labor-saving aid of the car itself which uses very little gasoline.

PENCIL TRACES GARDEN LABELS ON COPPER

LETTERING traced with a sharp-pointed pencil upon a new plant label for the garden will withstand indefinite exposure to the elements, according to the maker. The label is faced with a thin sheet of copper, backed with cardboard. Writing indented in the soft metal by the pencil point, in the manner shown above, is preserved long after the lead marks themselves are effaced.

BOTTLES HOLDING SHIPS ARE LOCKED TOGETHER

PUTTING a ship model in a bottle is not sufficiently difficult to suit Charles V. Nielsen, expert model maker of Hasbrouck Heights, N. J., so he has devised the remarkable ornament pictured at left. Twin ships in bottles are joined by a stick that bears two pegs at each end, preventing its withdrawal from either bottle neck. Nielsen accomplishes the seemingly impossible feat thus: First the ships are folded and slipped into the bottles, the masts being raised in the usual way with hooks and threads from outside. Then two pegs are dropped in one bottle. The connecting stick is now held in the neck, and the bottle is jiggled until a peg falls into a hole prepared with a drop of glue. It is shoved home by pressure against the bottle.

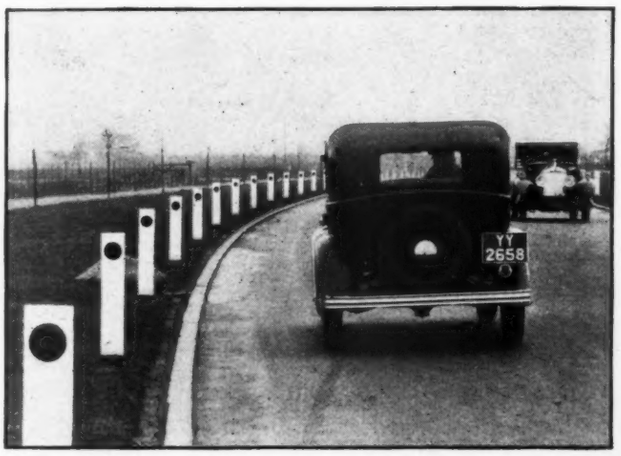
Charles V. Nielsen with two ships-in-bottles fastened together with a stick so pegged that it cannot be removed

RUSSIAN BALLOON TO INVADE STRATOSPHERE

A NEW challenge to the ten-mile altitude record of Prof. Auguste Piccard, made last summer in a globe hermetically sealed and carried aloft by a huge balloon, is offered by Russian scientists, who plan a similar ascent next month. Their balloon is being rushed to completion for the attempt, and an air-tight cabin is being built that will protect the flyers from lack of oxygen and reduced air pressure. A model of the cabin is illustrated above.

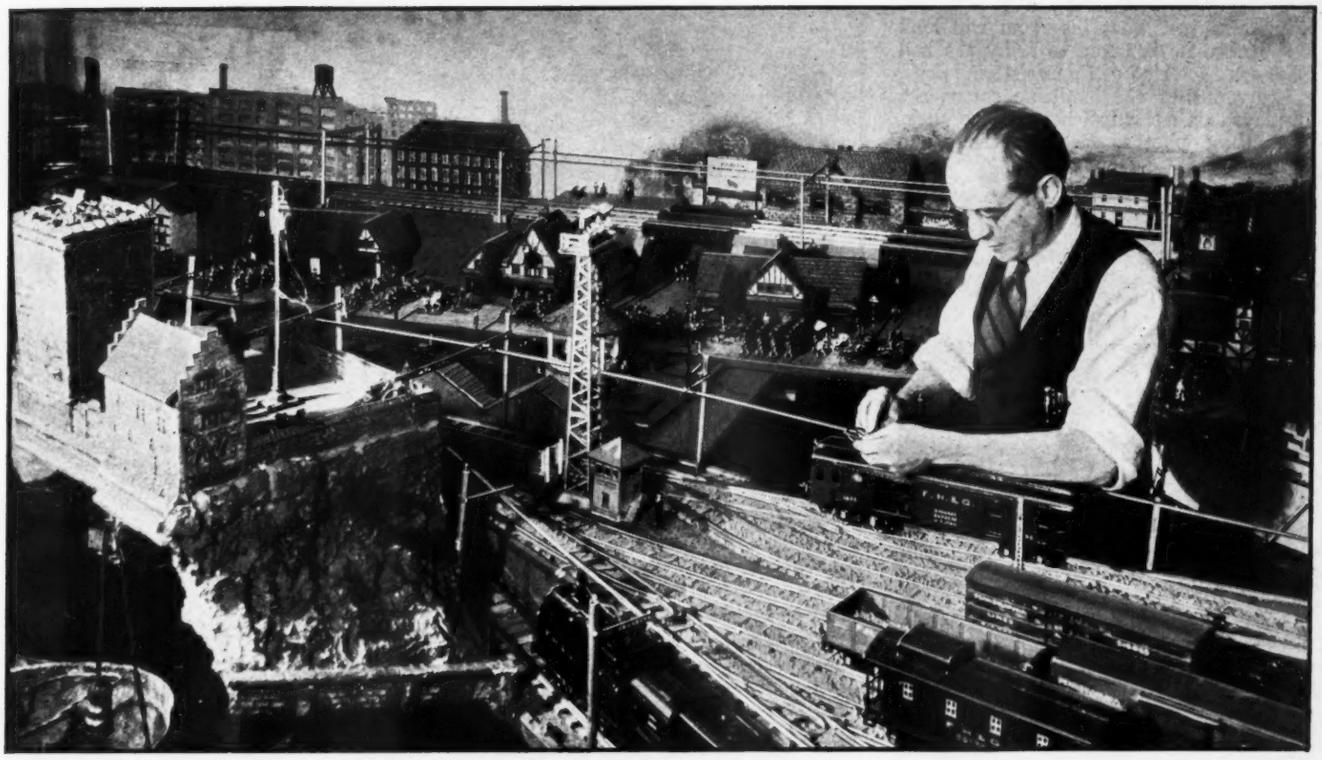
BULL'S-EYE FENCE POSTS GUARD BRITISH ROADS

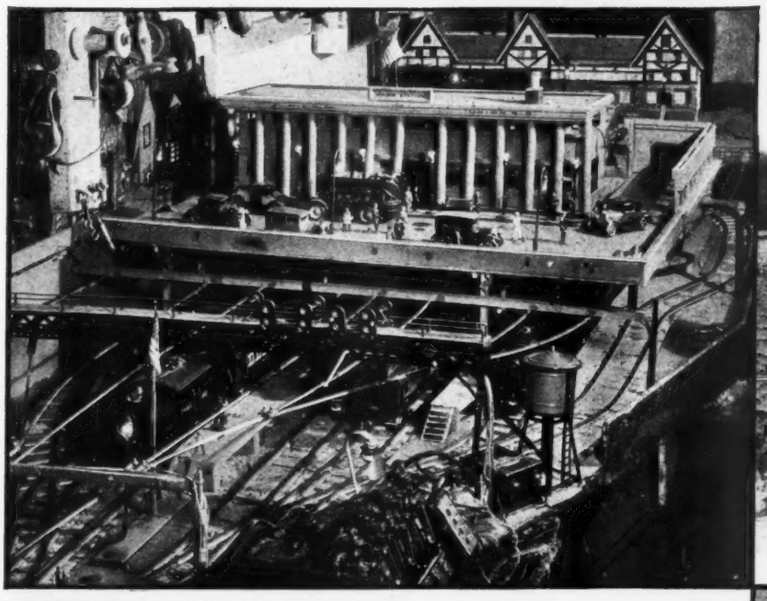
BULL'S-EYE fence posts safeguard night drivers against running off the road at dangerous curves of a highway near London, England. Red reflectors, resembling the individual danger markers used in this country, are sunk in the white posts and are brilliantly illuminated by the headlamps of an oncoming car. The unfamiliar position of cars and posts in the photograph is explained by the British custom of keeping to the left.



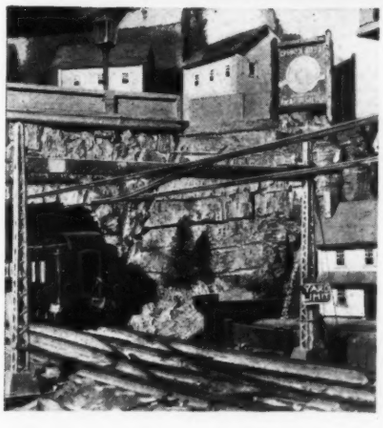
Bulls-eye posts guarding a curve on a highway in England

Model Railway Looks Like Real Thing





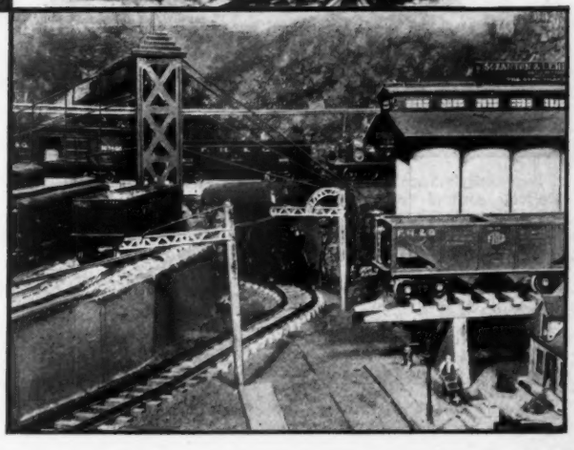
William H. Quarmby, Jamaica, N. Y., is at work in the midst of the elaborate model railway he has built in the basement of his home, pictures of which are reproduced on this page. Below is one of his most ingenious contrivances—a flood-light tower, erected in the yard of his system and looking like the real thing



A model Union Station, with autos crossing the ramp and trains diving into the interior or flashing outward bound, has a striking resemblance to the original it reproduces faithfully in all details

The realistic tunnel, left, is one of the many attractive features on Quarmby's system. Note, how genuine the stone work appears

Doesn't the picture, right, look exactly like a real railway coal yard? Everything used in handling coal for engines has been put in its right place and the realism is heightened by the manner in which scenes are painted on the concrete wall in the background

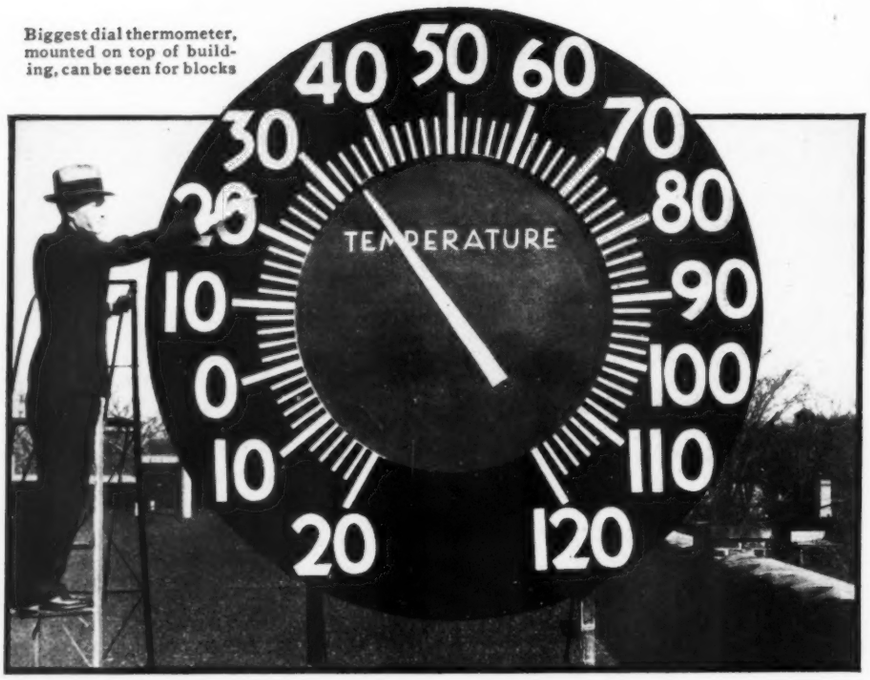


HOTEL GUEST SELECTS ROOM FROM PHOTOS

THROUGH a system just introduced in a Pittsburgh, Pa., hotel, a prospective guest sees just what his room will look like before he is taken to it by the bell boy. On each side of the registering desk, photographs of the available rooms are displayed on a vertical board. The clerk, with these photos, describes the room.

Pictures of rooms in Pittsburgh hotel are arranged in panel so guests can make their choice

Biggest dial thermometer, mounted on top of building, can be seen for blocks



BIGGEST DIAL THERMOMETER IS ON ROOF

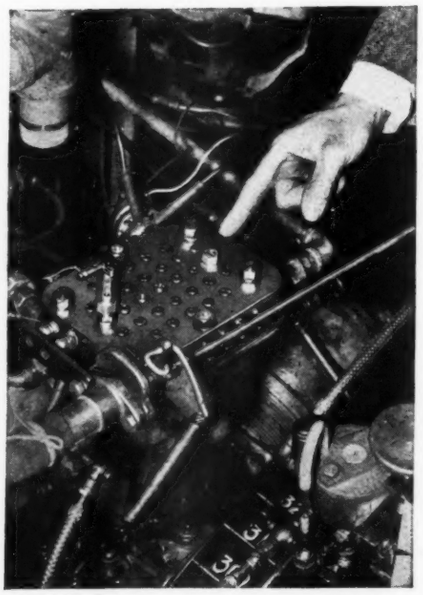
MOUNTED on the roof of a high building at Rochester, N. Y., the world's largest dial thermometer tells the temperature to observers blocks away. The face of the giant instrument is taller than a man, and a revolving indicator, painted white, points to figures a foot high. A large manufacturing plant erected the novel landmark as an advertisement for its products. In spite of its great size, the instrument responds accurately to all changes in temperature.

MICROPHONES CONTROLLED BY WIRES

MICROPHONES controlled by wires, like the characters of a marionette show, simplify broadcasting from a radio station at Cleveland, Ohio. The operator in the control room manipulates switches to move the microphones toward any part of the studio, in order to pick up sounds from individual actors or musicians. Each switch controls an electric winch above the ceiling, from which cables run through eyelets to the microphone. One cable carries the electric wires, while the other two are for support and control.

These switches are set in the control room of a broadcasting station. They are used to move the microphones from point to point in the studio much as marionettes are moved

At right, note the wires attached to the microphone. One of them carries electric current and the other two are used to manipulate the instrument to desired position



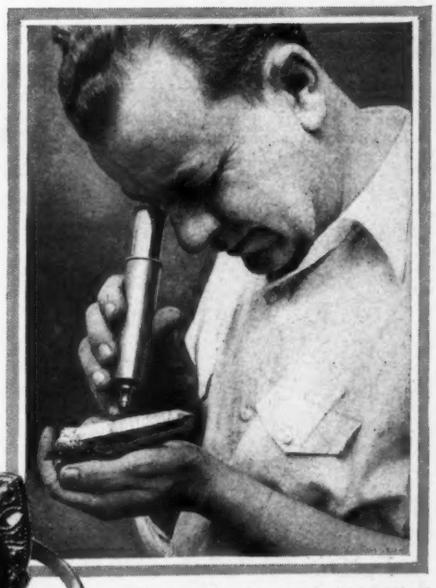
EXPERTS WATCH FLAME IN MOTOR'S CYLINDER

TO STUDY the manner in which flame spreads through a cylinder of a car's motor when the spark plug ignites the fuel mixture, experts of the U. S. Bureau of Standards have constructed a special cylinder equipped with windows, as shown above. Thirty-one symmetrically-spaced apertures in the top of the head permit the time of arrival of the flame at each point to be observed. The experimenters use a stroboscope which makes rapidly-moving objects appear to stand still.

Find Fortunes in American Gems

Latest Devices Aid Jewel Hunters in Their Search

ACCUSTOMED to exotic jewels—South African diamonds, Burmese rubies, Siamese sapphires—few people realize that fortunes await the gem hunter in the deserts and mountains of the western United States. Here modern prospectors, aided by the latest in labor-saving tools, are satisfying the current vogue for stones that owe their popularity more to their beauty than to excessive cost due to scarcity. Rock ledges, bordering Nevada deserts, yield turquoise but opal, amethyst, tourmaline, and beryl also are found.



With a microscope, the surface of this Arizona amethyst is being examined. It will cut about 150 carats

On this wheel, turquoise, found in Nevada, is ground down to shape it for setting in ring or ornament. A skilled workman will grind 200 of the stones in a day

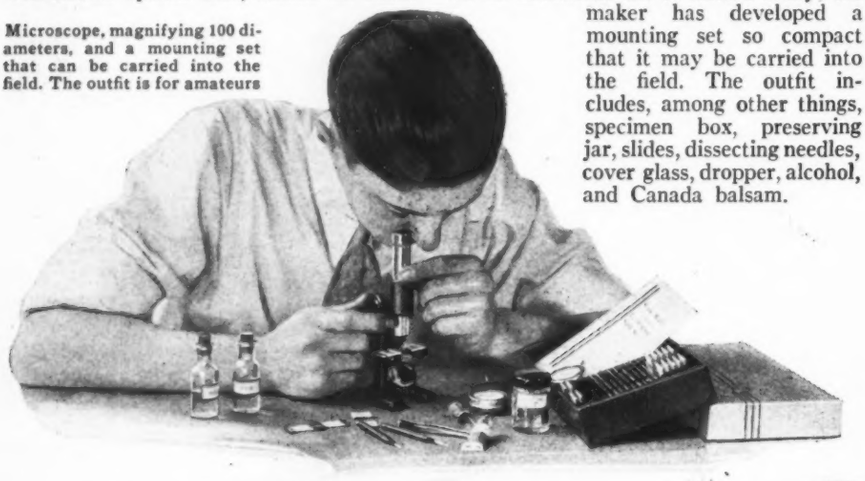
Before the turquoise is ground, as shown in the photograph at the top of this page, it is mounted on wax softened in an alcohol flame. In this way it can be handled conveniently during the grinding process. These cut turquoise stones are sold to Indians who have developed great ability at mounting them

In the oval, prospectors are shown seeking new stones in the gravel near a Nevada mountain. The gems are separated from the dirt in shaking tables driven by gasoline motors set up on the site of the gem mine

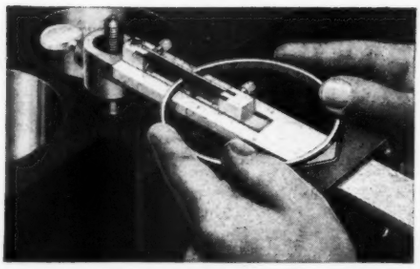
At left are two large stones polished and ready to be mounted. The white piece is a California moonstone and the other a Nevada jade.

NEW MICROSCOPE FOR AMATEURS

ESPECIALLY designed for the amateur who cannot afford an expensive instrument, a new microscope, introduced by a well-known optical firm, fulfills all needs at low cost. The instrument magnifies 100 diameters, and is provided with rack-and-pinion focusing and removable mirror. As an additional aid to nature study, the maker has developed a mounting set so compact that it may be carried into the field. The outfit includes, among other things, specimen box, preserving jar, slides, dissecting needles, cover glass, dropper, alcohol, and Canada balsam.



Microscope, magnifying 100 diameters, and a mounting set that can be carried into the field. The outfit is for amateurs



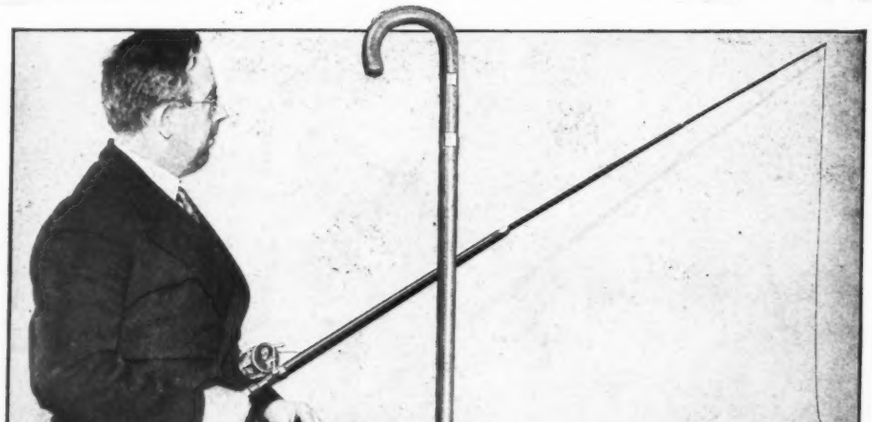
PISTON RING FILE HELD TO CYLINDER HEAD

COUNTLESS steps between the bench and the job are saved by a new piston ring file, that clamps directly to stud or cap screw in the cylinder head. The ring is held against a V-shaped plate and moved back and forth along a guide, while fingers press the ends against the file, as shown above. A few slides backward and forward give an accurate fitting in a fraction of the time usually required and with a minimum of effort, according to the maker.

ENDLESS COIL SPRING USED TO PUMP WATER

PICKING up a coil-spring curtain rod that had fallen into his bathtub, C. P. Frederick, of Seattle, Wash., was surprised at the amount of water that clung to the coils. The observation led him to design a new form of pump to raise water—an endless coil spring, running over a pair of pulleys, that dips in water at its lower end and throws it off into a collector at the top. Frederick plans to use the pump for irrigation and drainage.

Model of endless coil spring pump seen in action. Left, inventor with section of the type of spring used in pump



WALKING CANE IS ALSO A FISH POLE

A CANE that turns into a fish pole, as demonstrated above, permits a fisherman to try his luck whenever he encounters a promising stream. Telescopic fiber sections join to form a hollow shaft, through which the line is threaded from a detachable reel. The curved handle holds hooks, small sinkers, and an extra line. When closed, the cane is of conventional appearance.

HEAT RUNS THIS TINY ENGINE

BY HARNESSING the kick of a diminutive metal disk that snaps into convex shape when heated and back into concave shape when cooled, Westinghouse engineers claim to have created the world's first engine that turns heat energy directly into mechanical energy. Every ten seconds the disk is tossed between a heated, stovelike cylinder on one side of the device and an ice-cold cylinder on the other, by the unequal expansion and contraction of the two metals of which it is composed. Similar disks are used to make and break electric contacts in automatic temperature controls.

Snapping disk, in this engine, jumps rapidly back and forth between hot and cold cylinders

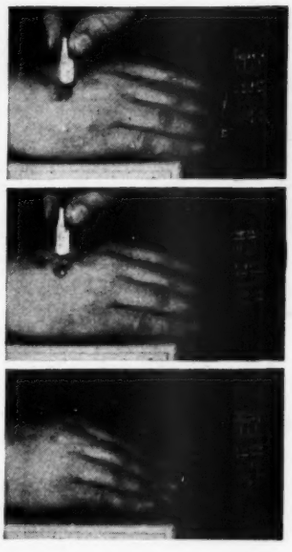
Timing Camera *takes* 2,000 Photos a Second

New ultraspeed timing camera with side removed. Finger points out timing dial which is photographed by one lens

SPLITTING a second into 1,000 parts, the world's fastest timing camera was demonstrated recently by engineers of the Electrical Research Products laboratories in New York City. It resembles in principle the cameras used to time runners at the Olympic games last summer, but it is 125 times faster. As a result of this great speed, the new camera will permit scientific work hitherto impossible. From eight to 2,000 pictures a second may be taken with ordinary lighting equipment.

Ultraspeed cameras have been constructed before, but the new instrument is the first to provide precision timing, in addition. While one of its two lenses records the action on the film, another is trained upon a set of revolving dials that register on every frame the exact time in minutes, seconds, and hundredths of a second. By estimating fractions of scale divisions in the finished record, the exact time may be gaged to a thousandth of a second.

Tests already made show the new camera's possibilities. Used to study the burning of photoflash bulbs used by photographers, it revealed that a subject who winks does so after the light has gone out. A man whose hand was touched momentarily by a lighted cigarette took more than a quarter of a second to react to the burn and jerk his hand away. When a glowing electric light bulb was shattered, the filament burned for a second.



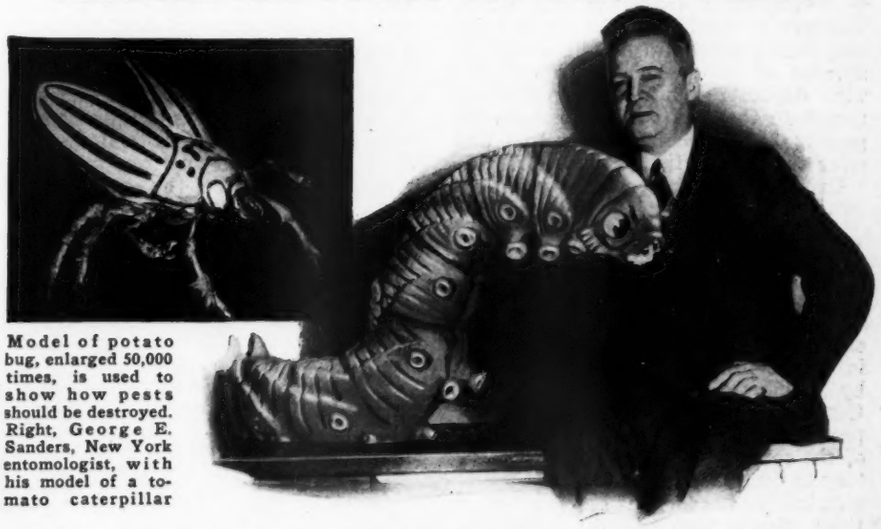
HOW FAST A BALLOON BURSTS

Views, right, taken consecutively by a superspeed camera, show that a balloon, touched by a burning cigarette, will burst so fast that the timing dials can scarcely make a record.

BURNING YOUR HAND

Three photos, left, show what happens when lighted cigarette touches hand. Second view shows cigarette removed before the hand starts to jerk away. It takes a quarter of a second to feel the pain and react to it.

MODELS AID FIGHT ON INSECT PESTS



Model of potato bug, enlarged 50,000 times, is used to show how pests should be destroyed. Right, George E. Sanders, New York entomologist, with his model of a tomato caterpillar

TO ILLUSTRATE his lectures on methods of combating insect pests, George E. Sanders, entomologist for a large New York chemical concern, has constructed enlarged models of familiar parasites. Faithfully copied from the insects as seen under a microscope, but enlarged as much as 100,000 times, they give a startling impression of realism. With the models' aid, Sanders explains why the chewing pests, such as caterpillars and potato bugs, must be destroyed by stomach poisons, while the smaller sucking insects are attacked best with chemicals that kill by contact.

CROOK DEALERS FOILED BY PACKAGED MOTOR OIL

MOTOR oil, packaged and sold in round cans, with the aid of a new dispenser, now foils the vendor of bootleg lubricant. Sharp-pointed prongs drain the original can in the motorist's presence. Thus he gets the brand he asked for as the can, once empty, cannot be refilled.

Grade Cotton by Guarded Samples

The lower part of the box, at left, contains cotton samples and the upper part pictures of them. So perfect are the pictures that every speck shows. Below, the plate used to make the cotton pictures is being dusted with a vacuum cleaning device

Samples of cotton, that furnish the standard for grading the world's supply, are photographed by Government experts and the picture placed in the box with the samples. This is done to prevent any possible fraud. At left, the photos are being taken by special process

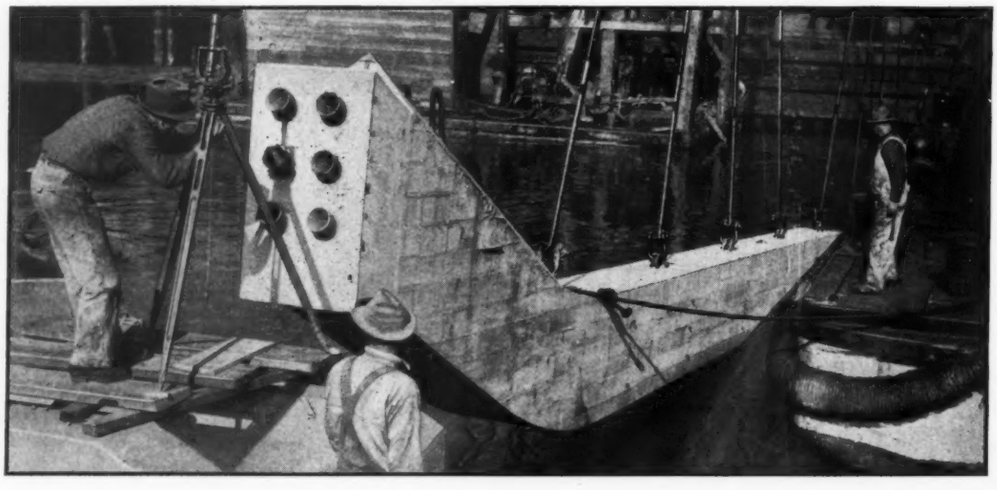
ARMED guards keep watch over a lead-lined casket in the U. S. Treasury at Washington, D. C. It holds only twenty cardboard boxes stuffed with samples of cotton—but these samples, with duplicate sets in other countries, constitute the final court of appeals for grading 25,000,000 bales of cotton that enter the world's trade every year.

Once the Liverpool market was the supreme arbiter of cotton standards, but now the U. S. Department of Agriculture, with its improved grading methods, safeguards the world supply. Every other year its experts prepare sixty-five duplicate boxes of standards for each of the twenty recognized grades of cotton. Each box contains a dozen samples from different bales of that grade, so selected as to show permissible variations in color and texture. When inspected and approved by an international committee, the standards are distributed to all countries. Certified copies are then made and issued to dealers.

Not overlooked is the danger that a criminal might somehow succeed in substituting inferior samples for the genuine ones. This would constitute a monster fraud that would permit the sale of low-grade cotton at a high figure. Hence a photograph of each box's contents, imprinted with the seal of the Department of Agriculture, is pasted inside the hinged cover. Alteration of a sample could be detected by matching it with the picture, which is made by a special process.

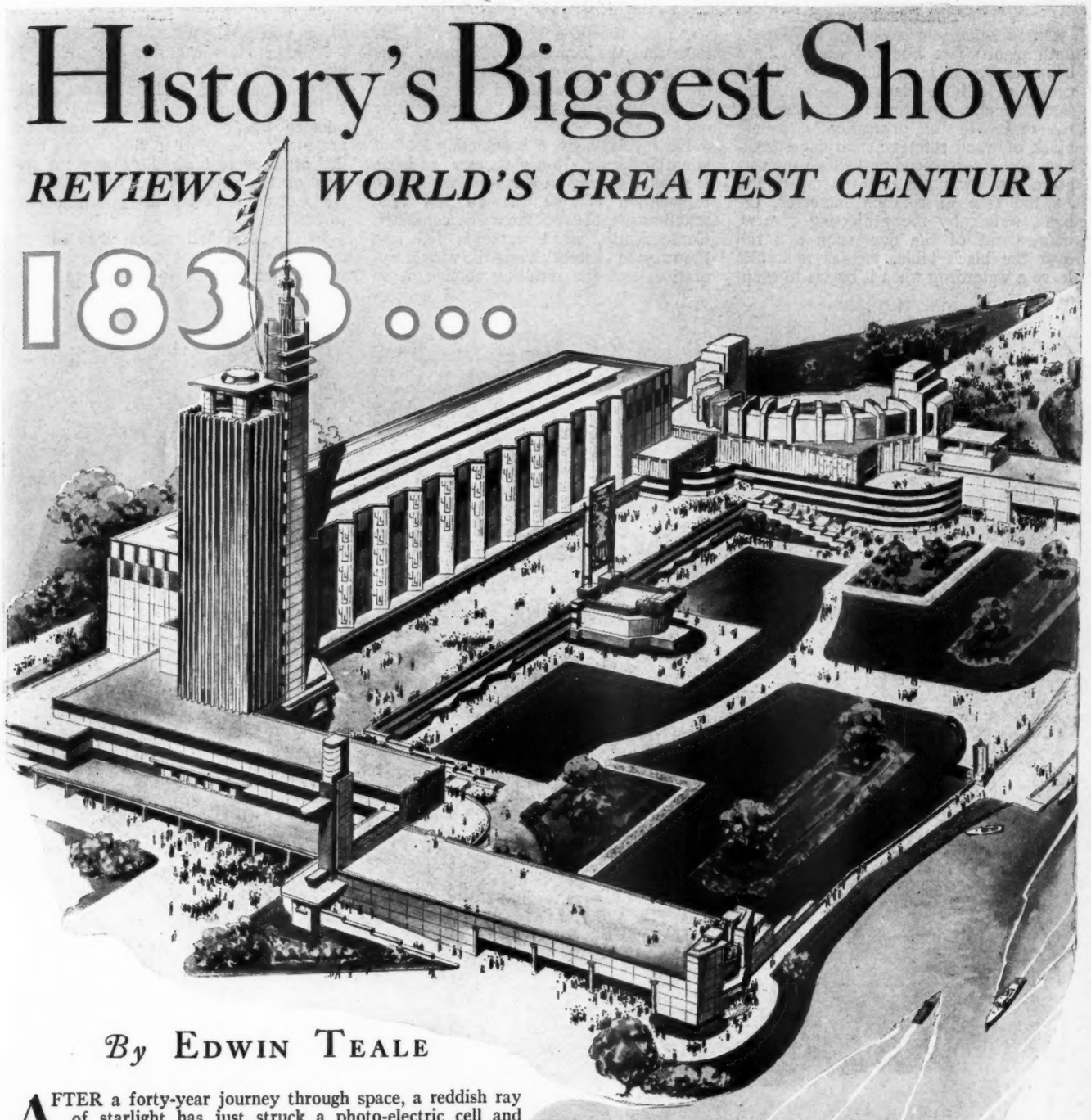
ELECTRIC CABLES PUT IN "SUBWAY"

A VERITABLE subway for electric cables, just installed in a San Francisco channel by Pacific Gas and Electric Company engineers, is expected to care for the needs of the community for a century to come. Engineers constructed two concrete sections, pierced with conduits, each 120 feet long and weighing eighty-five tons. Derricks lowered the sections into a trench nine feet below the channel bottom, as shown, while a diver directed the work by telephone.



History's Biggest Show

REVIEWS WORLD'S GREATEST CENTURY



By EDWIN TEALE

AFTER a forty-year journey through space, a reddish ray of starlight has just struck a photo-electric cell and flashed on the lights of a $25,000,000 extravaganza of science, the Century of Progress Exposition at Chicago.

Islands to accommodate the show, were built in the waters of Lake Michigan. Grass and trees and towering buildings cover them and hundreds of thousands of glowing, gas-filled tubes illuminate the great exposition.

Covering 338 acres, the thousands of exhibits compress into the scope of an exposition the drama and wonder of history's most amazing century of scientific advance. Under your eyes, crude rubber changes into auto tires; casein, extracted from milk, becomes a fountain pen; piles of parts turn into automobiles that speed away under their own power.

You see icicles forming on a red-hot wire and listen to an eight-foot talking tooth. You watch the blood circulate through the veins of a transparent man, read the temperature from a 200-foot thermometer, and see an umbrella made of water. Artificial Northern Lights flare and flicker in rainbow hues; educational pictures appear on curtains of steam, and prehistoric monsters, mechanically reproduced, feed and fight as they did millions of years before human history dawned.

Everywhere there is action. It is the key to the whole thrilling panorama. The exhibits at the Chicago Exposition show processes instead of products. They demonstrate how things are made and give exciting glimpses behind the scenes of science and industry.

Abstruse scientific laws, for instance, are made plain by athletes riding on whirling disks. How twigs grow and flowers are fertilized are shown through elaborate moving mechanisms. To make possible some of these exhibits, whole new machines had to be invented.

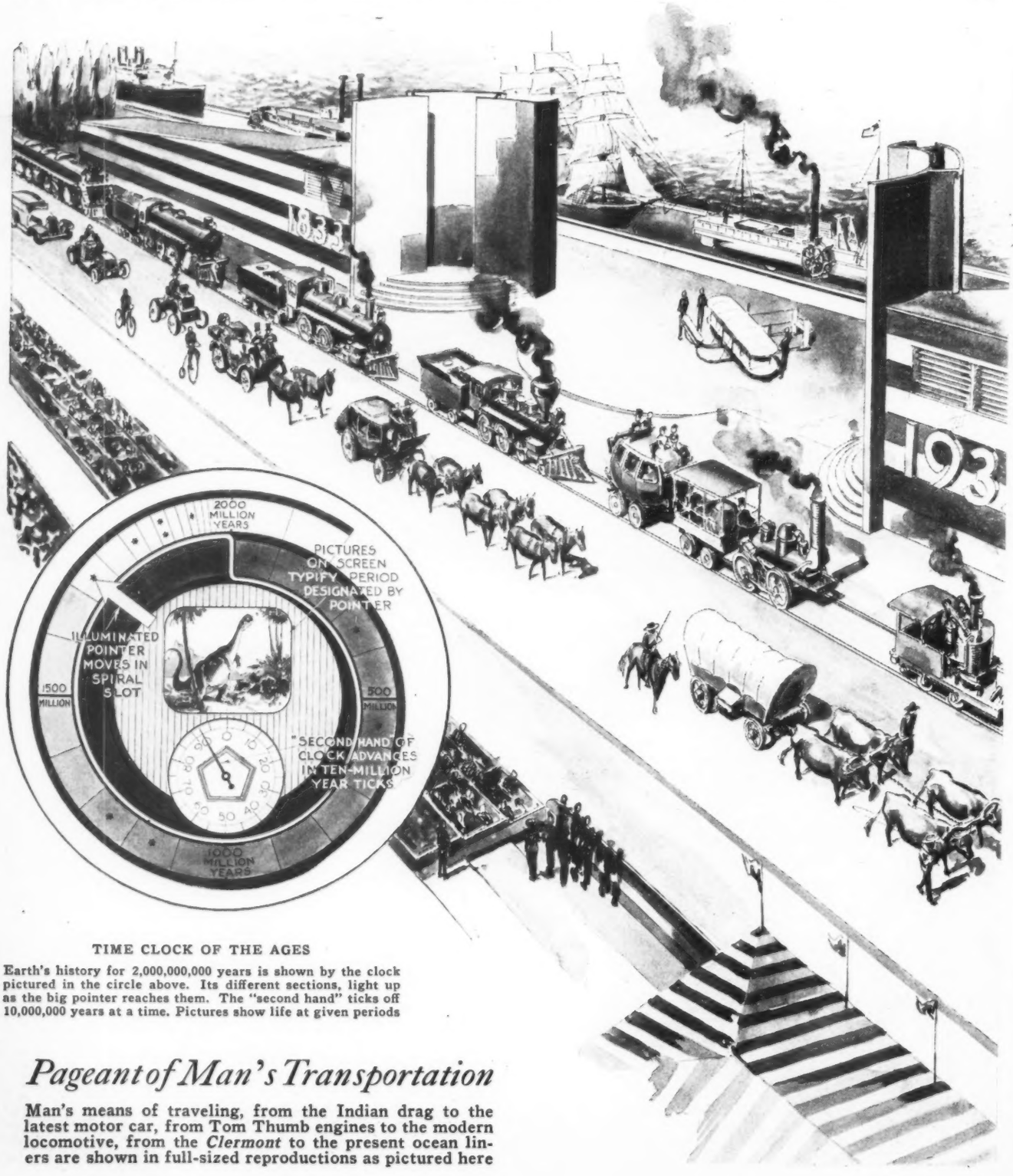
The central building, the great nine-and-a-half-acre Hall of Science, shown at the head of this article, is like a 300-ringed circus, every room containing its fascinating bit of dramatized human knowledge. In the physics section, more than a hundred displays turn textbook principles into action, light, and color.

Here a three-foot raindrop alternately evaporates and condenses from morning until night. Two hundred white billiard balls, clustered in a depression at the center of a huge black table, represent the molecules of water in a raindrop. At the center of the depression, a square block of wood rotates at varying speeds, high speed corresponding to high temperature and low speed to low temperature. As the rate of rotation increases, the balls, struck by the projecting corners, bounce out of the depression and roll over the black table, just as molecules leave a waterdrop when it begins to evaporate. When the block is spinning at top speed, all the balls are jostling over the table and the depression is empty. The raindrop has evaporated. Then the whirling block slows down and the molecules roll back into the depression, condensing once more.

Nearby is shown a bewildering feat of scientific magic. In a glass case, an icicle is slowly forming on a red-hot wire! The explanation is that the air has been practically exhausted from the container. Consequently, when water is fed into the vacuum chamber along the wire, evaporation, and the resulting cooling, is so rapid that the water turns to ice in spite of the heat of the wires.

Another glass chamber reproduces in miniature Piccard's flight into the stratosphere. Spectators see how the gas within a tiny balloon expands as the air is pumped out of the bell jar until the pressure corresponds to that of the rarefied atmosphere ten miles above the surface of the earth. Then they watch it contract again during the return journey to sea level.

In the main hall, below, they can examine the actual sphere of aluminum in which Piccard rode to his record height



TIME CLOCK OF THE AGES

Earth's history for 2,000,000,000 years is shown by the clock pictured in the circle above. Its different sections, light up as the big pointer reaches them. The "second hand" ticks off 10,000,000 years at a time. Pictures show life at given periods

Pageant of Man's Transportation

Man's means of traveling, from the Indian drag to the latest motor car, from Tom Thumb engines to the modern locomotive, from the *Clermont* to the present ocean liners are shown in full-sized reproductions as pictured here

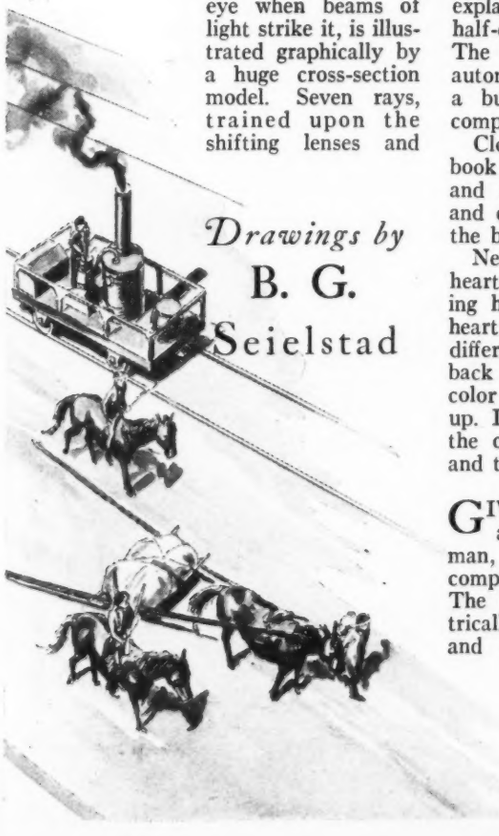
SPECTACULAR and ingenious exhibits, being prepared for the Century of Progress Exposition at Chicago, have been described in the pages of this magazine. Last month a feature article explained the elaborate plans of the U. S. Government. Here a staff writer for POPULAR SCIENCE MONTHLY, with the assistance of a staff artist, presents a vivid view of this great pageant. You are taken behind the scenes of some of the most amazing exhibits and told how their startling effects have been produced.

and beside it the steel bathysphere in which William Beebe descended 2,200 feet into the ocean off the shore of Bermuda.

AN UMBRELLA of water forms another spectacular display which demonstrates the force of surface tension in liquids. Running down the outside of a pipe, water is deflected by a broad-based cone at the bottom into an umbrella-shaped film which breaks into drops at its outer edge. When a little ether is added to the water at the top of the pipe, the tension is broken. Instantly, the umbrella collapses, opening again when the effect of the ether has passed away.

To make the exhibit even more striking, beams of light are shot down through the film so they are invisible until they reach the outer edge. Here they strike the forming drops that gleam and glitter like a border of flashing diamonds.

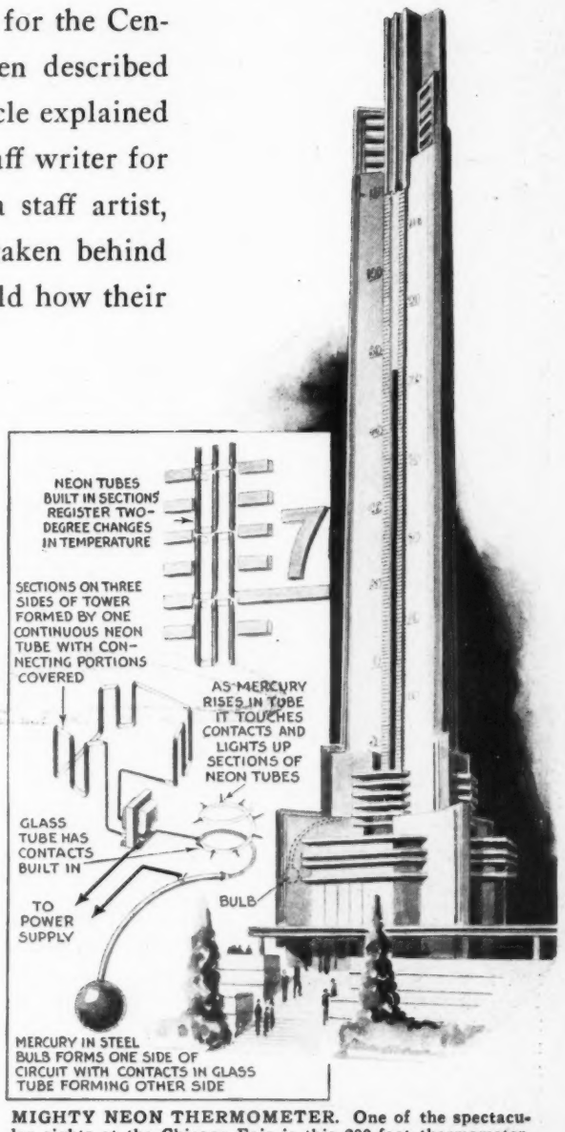
One whole room in the physics section is devoted to rays of various kinds. Just what happens inside a human eye when beams of light strike it, is illustrated graphically by a huge cross-section model. Seven rays, trained upon the shifting lenses and moving retinas of this three-foot model, demonstrate how eyes of normal vision, farsightedness and nearsightedness focus upon the same object.



Drawings by B. G. Seielstad

Not far off, among the medical exhibits, is a giant model of a throat. Vocal cords of variable tension demonstrate why one voice is bass and another soprano. Beside it is a monster brain lighting up different areas, which control various functions of the body, when corresponding buttons are pressed by spectators.

Towering eight feet in height is the talking tooth. A concealed projector behind it traces the processes of decay on the front of the tooth while a voice, coming from records which are synchronized with the projector, gives a lecture explaining each of the half-dozen steps shown. The whole apparatus is automatic, the pressing of a button producing one complete cycle of the show.


NEON TUBES BUILT IN SECTIONS REGISTER TWO-DEGREE CHANGES IN TEMPERATURE
7
SECTIONS ON THREE SIDES OF TOWER FORMED BY ONE CONTINUOUS NEON TUBE WITH CONNECTING PORTIONS COVERED
AS MERCURY RISES IN TUBE IT TOUCHES CONTACTS AND LIGHTS UP SECTIONS OF NEON TUBES
GLASS TUBE HAS CONTACTS BUILT IN
TO POWER SUPPLY
BULB
MERCURY IN STEEL BULB FORMS ONE SIDE OF CIRCUIT WITH CONTACTS IN GLASS TUBE FORMING OTHER SIDE

MIGHTY NEON THERMOMETER. One of the spectacular sights at the Chicago Fair is this 200-foot thermometer. Despite its huge size, this temperature recorder is accurate

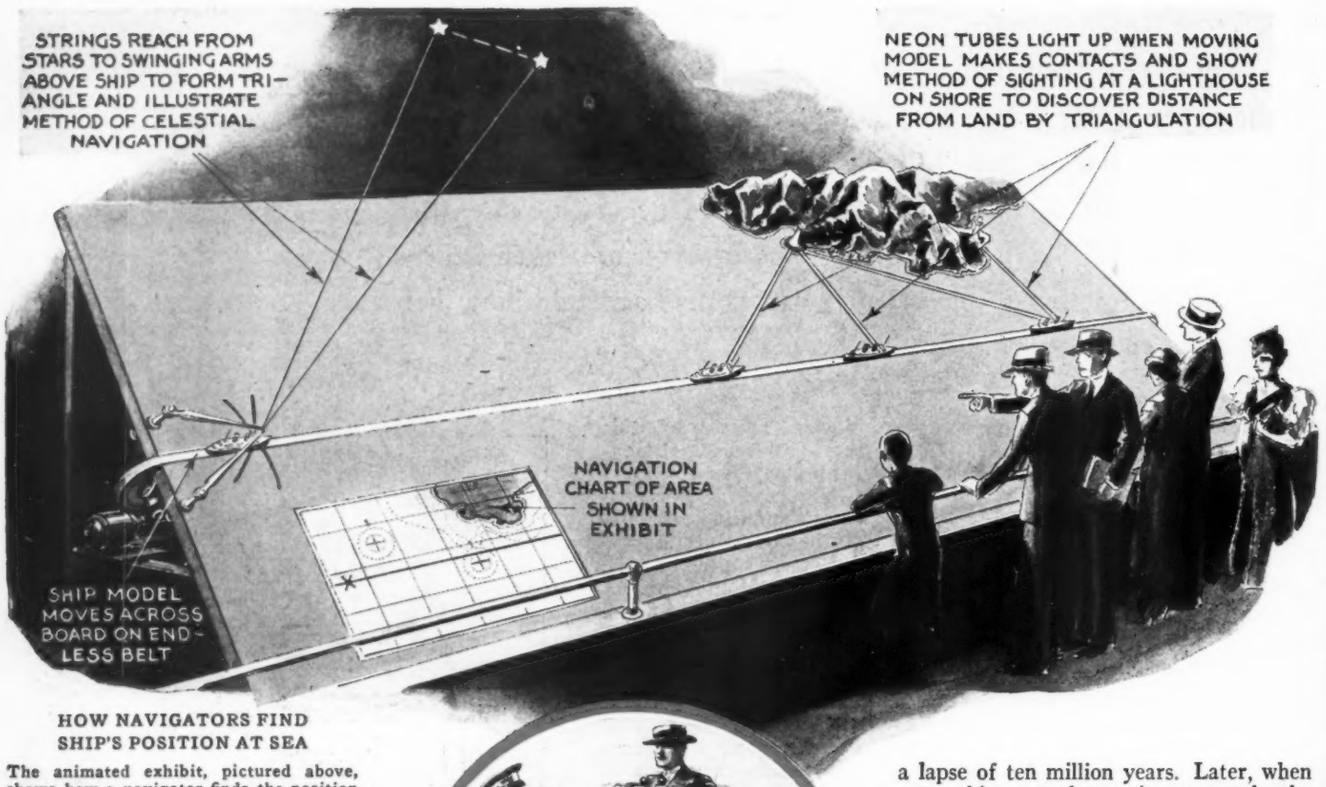
Close to the talking tooth is a magic book whose pages, each eight feet high and six feet wide, turn by themselves and carry information about the care of the body.

Next there is a robot with a leather heart and glass-tube arteries demonstrating how red blood is pumped from the heart and blue blood returns to it. The different-colored fluids appear to course back and forth in the same tubes, one color running down and the other color up. In reality, double tubes are employed, the one inside conveying the red liquid and the one outside carrying the blue.

GIVING X-ray eyes to the spectators, another exhibit shows a transparent man, a lifesize model of the human body composed of a glassy, cellulose material. The organs inside are illuminated electrically in rotation while their functions and relationship to one another are explained. In addition, the observer sees the complete skeleton of the figure, the veins and arteries of the circulatory system, and the network of nerves that lie beneath the transparent skin. The location of the various glands, the arrangement of muscles, and the working of the digestive system are also portrayed so visitors get a clear picture of human anatomy.

ANOTHER robot, in the chemistry section, is even more spectacular. Standing ten feet tall on its steel feet, this 1,500-pound metal man has a skeleton of aluminum castings, steel, brass, and lead weights. It turns its head, moves its lips and extends its four-and-a-half-foot arms in lifelike gestures under the direction of a small electric motor that forms the brain. When the vest of the huge mechanical man is unbuttoned, it reveals a white screen beneath. By means of a combined speaking mechanism and moving picture projector within the body, the robot gives a twenty-minute lecture upon food chemistry, emphasizing various facts by pointing to its own illuminated digestive organs appearing upon the screen.

One of the most difficult of all the exhibits to prepare was a diorama, or three-dimensional picture combining a painted background and modeled figures, which shows how sulphur is mined by driving superheated water into the ground


STRINGS REACH FROM STARS TO SWINGING ARMS ABOVE SHIP TO FORM TRIANGLE AND ILLUSTRATE METHOD OF CELESTIAL NAVIGATION
NEON TUBES LIGHT UP WHEN MOVING MODEL MAKES CONTACTS AND SHOW METHOD OF SIGHTING AT A LIGHTHOUSE ON SHORE TO DISCOVER DISTANCE FROM LAND BY TRIANGULATION
NAVIGATION CHART OF AREA SHOWN IN EXHIBIT
SHIP MODEL MOVES ACROSS BOARD ON END-LESS BELT

HOW NAVIGATORS FIND SHIP'S POSITION AT SEA

The animated exhibit, pictured above, shows how a navigator finds the position of his vessel. At left, strings represent sights taken on two stars used in calculating position by triangulation when out of sight of land. Right, neon tubes demonstrate the method used in computing the distance from shore by means of observations taken on a lighthouse while the ship is cruising along within sight of the coast

and floating the melted mineral to the surface. More than three months of experimental work was required to devise the elaborate arrangement of tubes and cylinders, wires and heaters, which reproduce in miniature the mining operation.

Vivid tongues of whirling flame, liquids that shift colors like a chameleon, and a twenty-five-foot "living" table of the elements are other dramatic displays in the chemistry group. Besides exhibiting specimens of most of the ninety-two chemical elements of the earth, the table displays a ten-foot revolving globe indicating the main sources of the different elements.

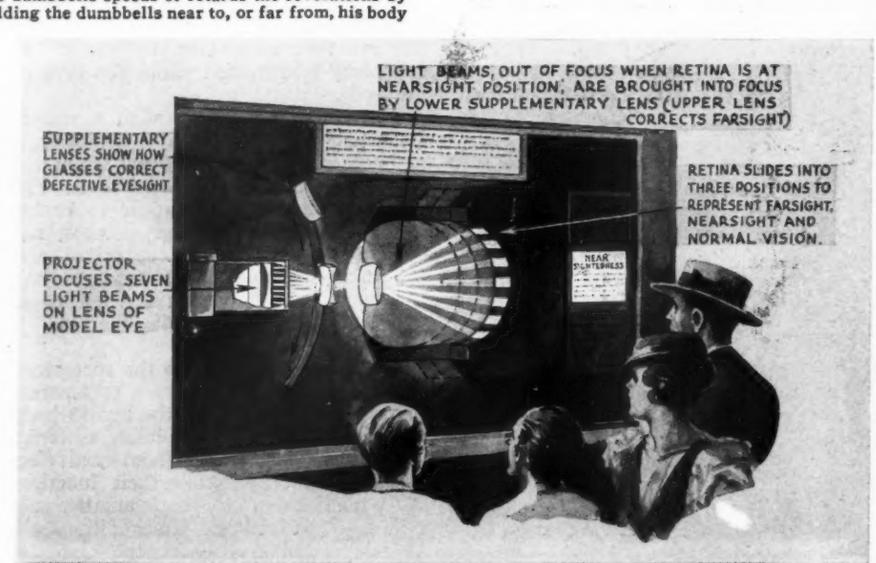
Dramatizing the story of the earth and life upon it is a geological Time Clock of the Ages which compresses two billion years of history into the space of four minutes.

LIKE an eight-foot snail's shell, the face of the clock is formed by a widening spiral along which an illuminated pointer travels, each brilliantly-colored sector of time lighting up at its approach. The principal events upon earth, such as the first appearance of life, are marked by stars. At the center of the clock is a screen, three by two feet, upon which appear, at eight-second intervals, pictures showing conditions on earth at the time indicated by the traveling pointer. Below the screen, a "second hand" ticks off the time, each tick at first representing a lapse of ten million years. Later, when more things are happening on earth, the hand automatically slows down. Man appears just when the final tick of the clock is sounding.

As you move on to other exhibits of the geology group, you watch miniature rivers, canyons, and deltas form under your eyes; you follow the history of petroleum from its formation in the ground to its final emergence from the refinery as gasoline; you see synthetic sand dunes form and slowly march back and forth in the grip of shifting winds.

A machine that makes mountains is another unusual contrivance. Layers of sponge rubber, weighted down with lead shot, represent rock strata in the earth. Screw mechanisms at either end slowly

Standing on this revolving platform, the man with the dumbbells speeds or retards the revolutions by holding the dumbbells near to, or far from, his body


LIGHT BEAMS, OUT OF FOCUS WHEN RETINA IS AT NEARSIGHT POSITION, ARE BROUGHT INTO FOCUS BY LOWER SUPPLEMENTARY LENS (UPPER LENS CORRECTS FARSIGHT)
SUPPLEMENTARY LENSES SHOW HOW GLASSES CORRECT DEFECTIVE EYESIGHT
RETINA SLIDES INTO THREE POSITIONS TO REPRESENT FARSIGHT, NEARSIGHT AND NORMAL VISION.
PROJECTOR FOCUSES SEVEN LIGHT BEAMS ON LENS OF MODEL EYE

This heroic reproduction of the human eye presents a graphic demonstration of the mechanics of vision. Lenses are moved in front of the eye's lens to show how glasses correct defective sight

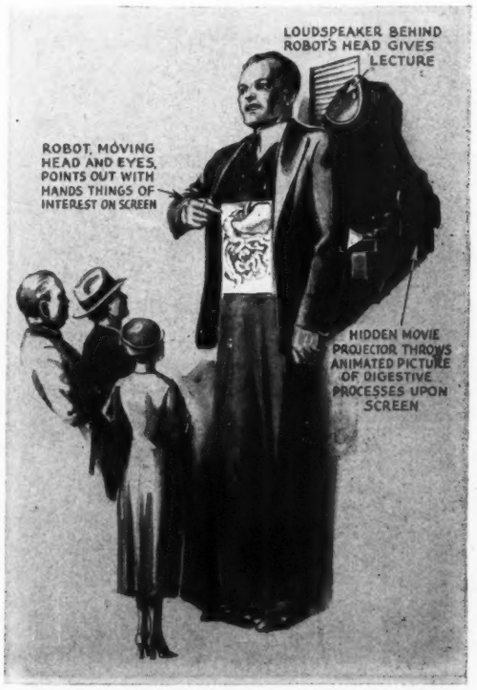
• Animated Panorama Gives Exciting Glimpse

compress the layers to reproduce the folds and thrusts which, on a titanic scale in the earth's crust, have brought about the Rockies and the Andes.

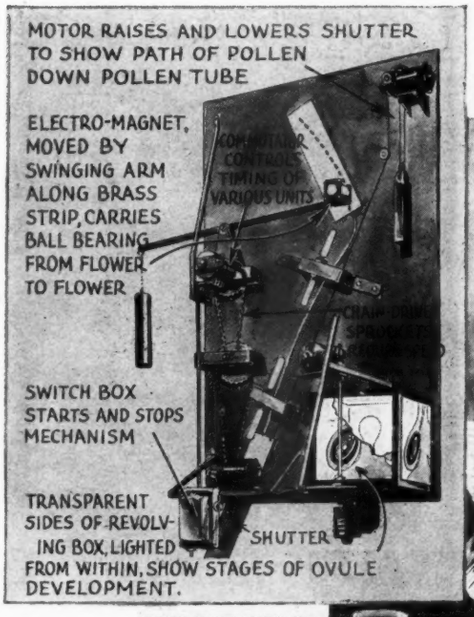
In the reproduction of the sand dunes, a fourteen-foot diorama depicts a scene along the southern shore of Lake Michigan between Gary and Michigan City, Ind. Fine grains of a light oxide are employed as sand. In an endless circular tunnel, of which the diorama is part, a hidden fan sends a steady current of air over the sand heaps, piling them into great mounds that move slowly along the shore burying miniature forests and tiny houses which lie in the way. Then the fan is reversed, sending the wind through the tunnel from the opposite direction, and the shifting sand hills march back again across the stage bringing to light once more the buried trees and buildings.

TURNING a mathematical formula into an exciting spectacle may seem impossible, but that is what is done by one exhibit at Chicago. An athlete, standing on a small platform, holds two iron dumbbells extended at arm's length at either side. An initial shove starts the platform turning almost without friction on its ball bearings. For a few moments, it continues to rotate at the same speed. Then a show of seeming magic starts. The athlete draws the dumbbells in to his chest. The platform speeds up. He extends his arms again. It slows down. He draws the weights slowly in to his body and the platform whirls at a steadily increasing pace. A dozen times, you see this weird performance occur, giving a demonstration of a basic law of mechanics relating to mass, force, and acceleration.

Other moving displays, by means of varicolored streaks of light, weights that fall bumping through mazes of steel pins, and toy ships that steam among the islands of a papier-mâché sea, depict graphically other natural principles.


LOUDSPEAKER BEHIND ROBOT'S HEAD GIVES LECTURE
ROBOT, MOVING HEAD AND EYES, POINTS OUT WITH HANDS THINGS OF INTEREST ON SCREEN
HIDDEN MOVIE PROJECTOR THROWS ANIMATED PICTURE OF DIGESTIVE PROCESSES UPON SCREEN

On a screen representing his stomach, animated pictures are thrown while the 1,500-pound robot gives a twenty-minute lecture on the chemical process of digestion, indicating the various steps


MOTOR RAISES AND LOWERS SHUTTER TO SHOW PATH OF POLLEN DOWN POLLEN TUBE
ELECTRO-MAGNET, MOVED BY SWINGING ARM ALONG BRASS STRIP, CARRIES BALL BEARING FROM FLOWER TO FLOWER
COMMUTATOR CONTROLS TIMING OF VARIOUS UNITS
SWITCH BOX STARTS AND STOPS MECHANISM
TRANSPARENT SIDES OF REVOLVING BOX, LIGHTED FROM WITHIN, SHOW STAGES OF OVULE DEVELOPMENT.
SHUTTER

STEEL BALL, REPRESENTING GRAIN OF POLLEN FROM MALE FLOWER, MOVES DOWN FACE OF PICTURE TO PISTIL OF FEMALE BLOOM
MOVING SHUTTER SHOWS, BY STREAK OF LIGHT, PATH OF POLLEN DOWN POLLEN TUBE TO OVULES
FOUR PICTURES OF MAGNIFIED OVULE SHOW DIFFERENT STAGES IN DEVELOPMENT AFTER FERTILIZATION
OVULE

MOVEMENTS OF POLLEN DUST

An illuminated eight-foot flower is fertilized by a steel ball that represents a grain of pollen and rolls down to start the development of seed in the ovule. Light streaks show the progress of the pollen. The inset shows the involved mechanism behind the picture that controls operations

Imagine a pair of brilliant flowers, seven feet high! That is what first attracts your attention when you come to the biology displays. The gladioli blooms form the heart of an animated picture which reaches to the ceiling and illustrates the pollenizing process of plants. As you watch, a large steel ball, representing a grain of pollen, rolls down the face of the picture from the upper male flower and comes to a stop as it touches the pistil of the female. Then a streak of light moves down the pollen tube and shows the path the pollen takes in reaching and fertilizing the ovules.

Four illuminated pictures, appearing one after the other to the left of the flower, give magnified views of the fertilized ovule, showing different stages in the development of the seeds. In the meantime, the ball has rolled, as if by magic, back up the face of the picture and is in position to start the show all over again.

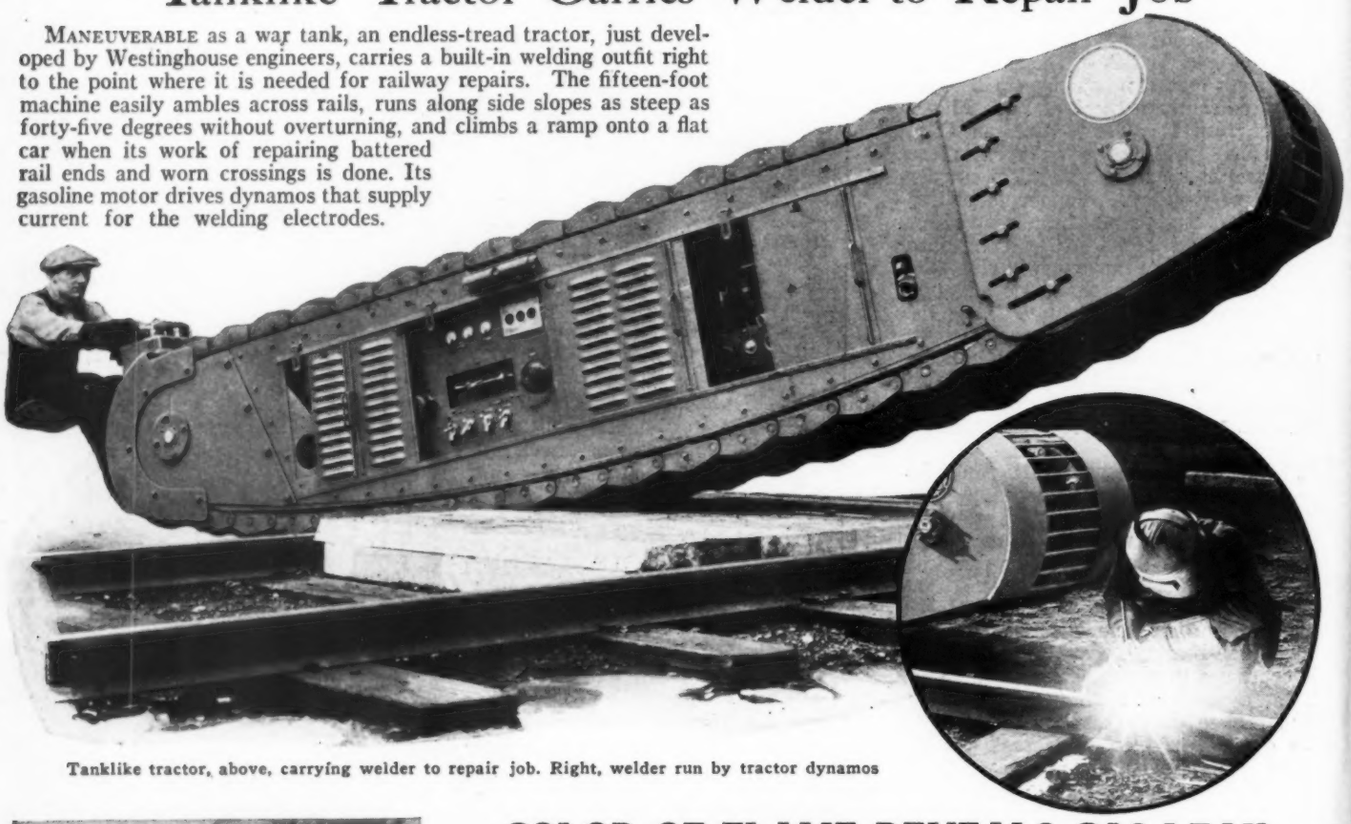
THREE electric motors, a magnet on a moving arm, a transparent, revolving box, and an elaborate system of weights and counterweights are required behind the scenes to make this demonstration possible. An electro-magnet moves along a strip of brass behind the steel ball leading it along from flower to flower. A sliding shutter, slowly opening and closing a slit, lighted from behind, produces the illuminated path of the pollen down the tube and a revolving box, having its four transparent sides lighted from within, shows the four stages of seed development. The whole process is automatic, a central commutator controlling the timing of the various units.

Beyond the flowers, six projection outfits, called micro-vivariums, make visible the strange, infinitesimal world which lies in a drop of water. Each apparatus throws a huge disk of light upon a screen and peoples it with the magnified images of microscopic creatures, enlarged thousands of times. You see these monsters of a minute world dart about, forage for food, fight, reproduce.

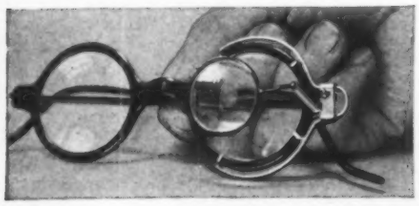
The impression, as you pass from one disk to another, each showing a different sort of microscopic colony, is that of looking into the tanks of some aquarium filled with most *(Continued on page 91)*

Tanklike Tractor Carries Welder to Repair Job

MANEUVERABLE as a war tank, an endless-tread tractor, just developed by Westinghouse engineers, carries a built-in welding outfit right to the point where it is needed for railway repairs. The fifteen-foot machine easily ambles across rails, runs along side slopes as steep as forty-five degrees without overturning, and climbs a ramp onto a flat car when its work of repairing battered rail ends and worn crossings is done. Its gasoline motor drives dynamos that supply current for the welding electrodes.



Tanklike tractor, above, carrying welder to repair job. Right, welder run by tractor dynamos



EXTRA EYEGLASS LENS CLIPS TO ANY FRAME

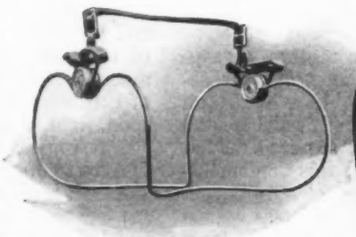
DESIGNED to be clipped to the frame of a pair of spectacles, a new type of lens enlarges reading matter so the use of a hand reading glass becomes unnecessary. It is roughly the size of a quarter and is held about an inch in front of the regular spectacle lens. The clip, of spring metal, may be snapped on or off any shape of frame in a moment. When reading matter does not require magnification, the lens can be flipped upward on its hinge out of the line of vision. A small coil spring holds it firmly in this position.

COLOR OF FLAME REVEALS GAS LEAK

GASES that leak from refrigerating plants, and other fumes difficult to detect by ordinary means, are quickly revealed by an ingenuious burner patterned after a blowtorch. The device, burning alcohol, normally has a clear blue flame. When a rubber tube on the torch is held near a gas leak, however, as shown in the photograph at the left, some of the gas is sucked through the tube to the burner and the flame changes color. If the flame turns green, for example, when the tube is held near a suspected pipe connection, the source of the leak has been found. The method is said to be especially useful when the escaping gas is of an odorless type, and therefore more troublesome to trace than fumes can be detected by the nose.

ICE-TONG LIFTER FOR RESCUE WORK

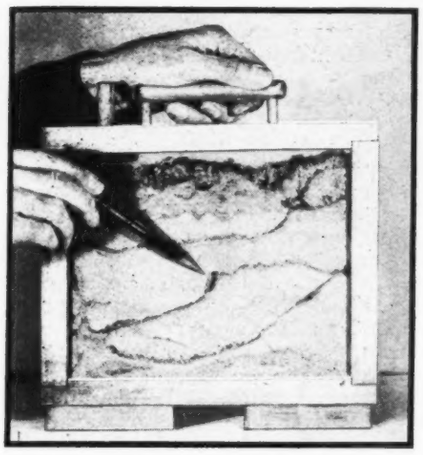
WORKING like ice tongs, an ingenious rescue device enables an invalid to be carried safely from a burning building. Metal loops grasp the human burden; the greater the weight, the more firmly they grip. A leather strap encircles the rescuer's neck, leaving his hands free. The inventor also recommends his device for use in hospitals.



Working like ice tongs, this lifter's grip is increased by the weight raised. Right, lifting an invalid with the device

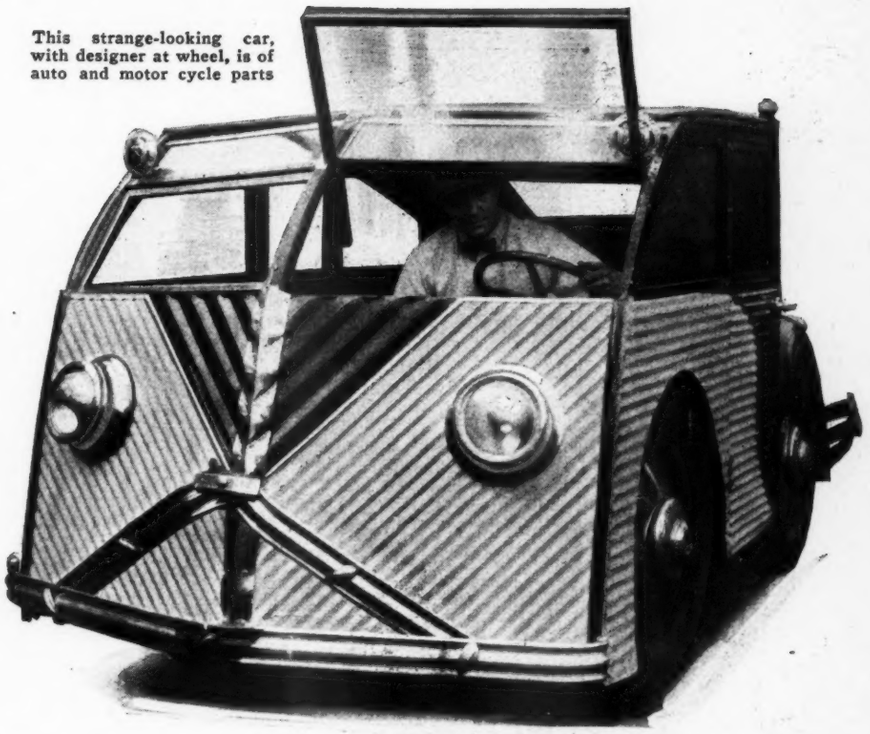
WONDERS OF ANT LIFE SEEN IN GLASS HOME

BETWEEN two photographic plates, held in a wooden frame, a New Hampshire naturalist placed dirt and thus constructed an anthouse with transparent walls. By this means the activity of an insect city is easily studied. The tunnels and subterranean chambers made by the ants are clearly visible and their work can be seen from each side of the glass home. The transparent cages offer more varied activity than a goldfish bowl, and the ants require much less attention than goldfish. The case is provided with a handle.



Two panes of glass, with dirt between them, make home in which ant is studied

This strange-looking car, with designer at wheel, is of auto and motor cycle parts



TURTLELIKE CAR BUILT OF OLD PARTS

FROM spare auto and motorcycle parts, a Chicago mechanic has built a freak vehicle which he calls a "turtle on wheels." The total cost, he says, was about twenty-five dollars. Made of corrugated metal, the turtle-shell body extends beyond the wheels on each side, reducing wind resistance. On country highways, according to the builder of the strange machine, the little car makes forty-five miles an hour, driven by a motor placed at the rear. A special triangle of bumpers protects it.

DIME PUT IN SLOT RINGS DOORBELL

Only after a coin has been deposited in the slot, as shown at the right, does the doorbell ring. The housewife can thus be reasonably sure the caller is one having legitimate business with her. This protects her against the intrusion of annoying or casual callers

TO SAVE a busy housewife from frequent annoyance by unwelcome callers, a doorbell that works only upon the insertion of a dime is soon to be marketed. The coin slides into an inside receptacle, where it closes an electric contact that permits the bell to be rung. If the caller proves to be a friend, the dime is returned as the guest enters; if the visitor is a stranger or one to whom entrance is refused, the money is retained. Dimes kept by the device provide a fund for charities.

The interior of the coin-in-slot doorbell is shown above. The coin slides into receptacle inside the door where it closes electric contact and rings bell. Housewife can return the money

TINY MICROPHONES HELP SINGER MAKE RECORD

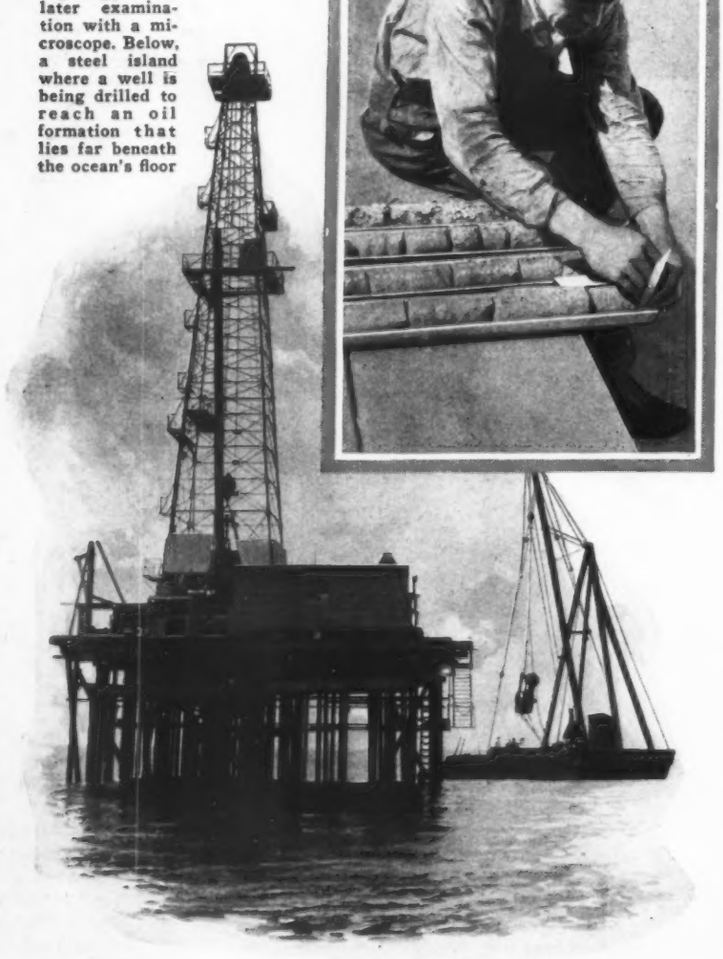
MINIATURE microphones, placed on a singer's chest and forehead, as shown above, supplement standard equipment in making electrical transcriptions at a Los Angeles, Calif., studio. By this method, the originator says, it is possible to make a record that sounds even better than the voice of the performer in person, since the small microphones pick up tones undistorted by faulty nose or mouth technique.

Lost Oil Fields

FOUND BY MODERN MARVELS

With the core bit shown here, cylinders are cut from the various strata of rocks and sand through which the drill passes as a well is sunk

Cores, right, taken at various depths from an oil well, are being tagged for later examination with a microscope. Below, a steel island where a well is being drilled to reach an oil formation that lies far beneath the ocean's floor



FABULOUS treasure in the world's lost oil fields is today the goal of a new search. It is being sought by a new school of scientific detectives—men who read clues from microscopic bugs dead millions of years, or from photographs snapped from an airplane at a 10,000-foot altitude; who sound the earth with miniature electric vibrators, release migrating electric currents to explore hidden depths, measure changes of one-millionth part in the earth's gravitational field, or follow a trail of radium to subterranean levels never before probed by man.

The lost oil fields are those passed over by explorers of other days who were unaided by modern science. Some are deeper than ever the driller's bit has penetrated and can be reached only with the aid of machinery of hitherto undreamed power. Others lie locked in blind formations—huge subterranean domes whose contours are invisible at the surface, and whose discovery depends upon ultra-modern geological methods. Still others have been penetrated by wild-catters in the past, yet were not detected by drillers unaided by delicate chemical tests lately devised. In such fields remains the bulk of the world's untapped store of oil.

Hidden beneath flat, marshy sands along the ocean lay one of California's lost oil fields. Close by, several wildcat wells had been abandoned as failures. Then along came a geologist of the new school. From the unsuccessful drillers, he obtained cores from their wells—long cylinders cut out of the earth by a bit shaped like a cookie-cutter. These were perfect cross sections of the underground strata. The grayness of the cores was flecked with tiny pin points of white, like minute specks of chalk. Crushing the cores, washing them, boiling them in lye to remove the binder material, this geologist picked out the tiny specks and placed them upon the slide of a microscope. Under the lens, he saw beautiful sea shells, glistening and perfect.

PAGES of earth's history turned back. These minute fossils, dead millions of years, were types of sea animals that lived when the earth was young. Each species represented an epoch in which myriads of such minute bits of life flourished and died. This, brought up from a certain depth, represented the Pliocene; this, the later Miocene; this, the Oligocene, dating back sixteen millions of years. Aided by this geological calendar, he identified each formation. Here is was found at 3,000 feet; here it rose to 2,600; here, nearer the ocean, it was still higher.

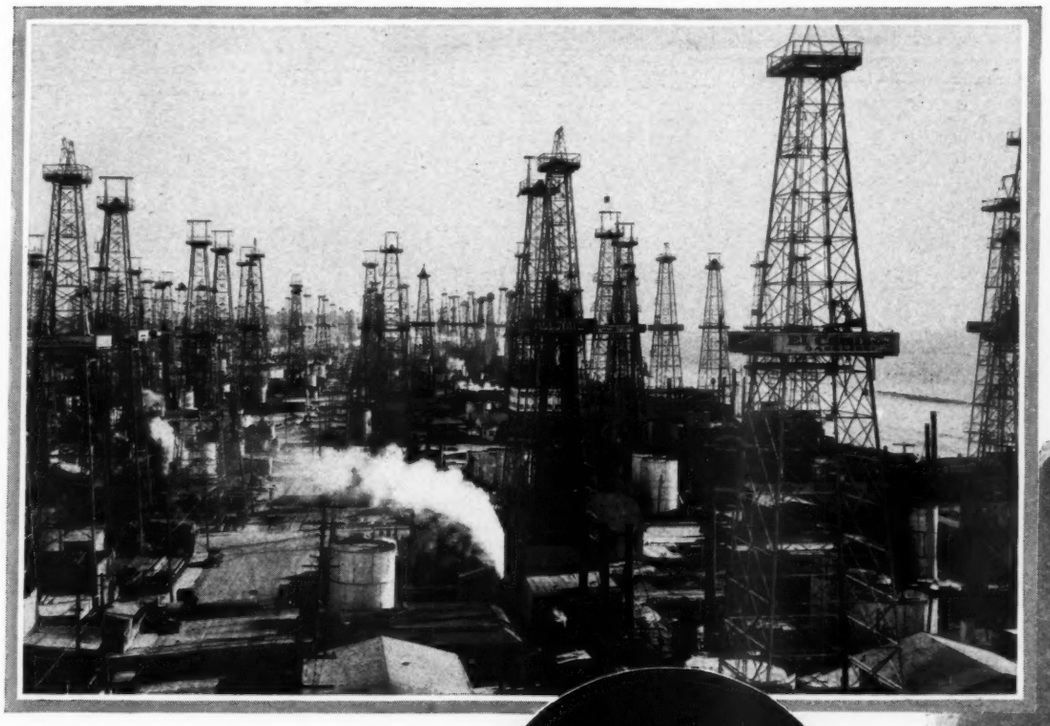
Mentally extending these hidden contours, buried beneath the accumulated deposits of later ages, he saw them sweep upward to form a great dome. At the crest, in a formation known to be oil-bearing in other regions, he visualized a pool of oil, rising on subterranean currents of water to the highest point possible, and so trapped underneath the rocky cap of the dome.

"Drill here," he said.

Six thousand feet beneath the flat marsh at the point he indicated, they struck oil.

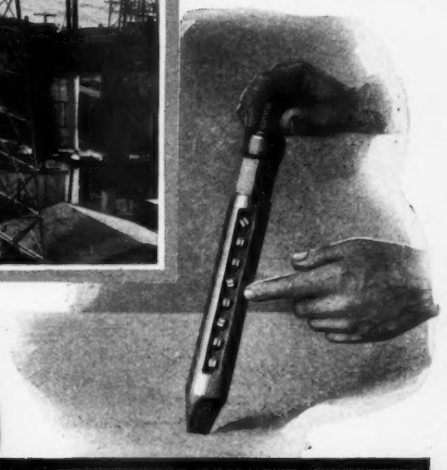
News of oil travels fast. Machinery costing $28,000,000, rapidly transformed the area into a forest of derricks—150 erected within a year. The production became so large, it temporarily upset the market and sent the price of this grade of oil tumbling to half its former value.

So was born the new science of micropaleontology. Now, only three years later, most of the major oil companies maintain staffs of these men who examine cores, classify the various types of "bugs," or foraminifera, and make charts showing the depths at which each of the hundreds of types is found. From fresh cores of drilling wells, they read fascinating stories of past ages when the ocean swept

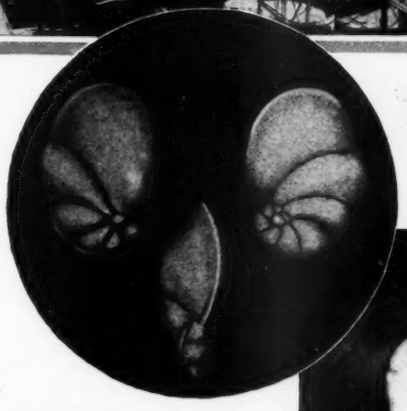


By
STERLING GLEASON

Left, a typical oil field with its forest of derricks marking the locations of its innumerable wells. Below, a temperature bomb used in searching for salt domes. The plugs, of fusible alloys, have different melting points, thus indicating the temperature below the surface and supplying clues as to the presence of oil and gas



Microscopes, airplanes, and electrical devices now used in mapping the treasure-holding domes beneath earth's surface



Picture, above, shows one type of marine shell found far below the earth's surface and used by scientists in outlining the hidden oil formation. Right, the Brunton compass with which the dip of a formation is studied. This compass was used in tracing a field that ran out to sea

over the places where oil is being sought far beneath the earth's surface.

"Fish scales, spines of sea urchins, wood fragments, and pieces of lignite coal occur in great abundance in some wells," Earl B. Noble, geologist, told me. "Shark teeth, crab claws, worm borings, and fossil fish are occasionally found. Even ripple marks, mud cracks, and rain marks can be recognized.

"A few days ago a gas blow-out occurred in an oil field. Many of the people watching the well were surprised to see perfect little shells appearing on the hats and shoulders of their neighbors. It literally was raining fossils, for the well had penetrated the Amnicola zone and was blowing these tiny shells high into the air."

Although some fossils are found at almost all depths, certain species had a life history quite short, geologically speaking, and hence clearly define their epoch. These markers tell the geological story of the area with great precision.

In a flat, barren region of the San Joaquin valley in California, geologists suspected the existence of an oil or gas formation. Instead of drilling at random, they put down a series of core-holes at chosen points. Correlating the bug indications from the test-holes, they mapped out a subsurface picture that indicated a favorable formation.

The discovery well ran into a gas zone which blew out with pressure of 60,000,000 cubic feet of natural gas. As subsequent wells were drilled around the geological bullseye in accordance with the directions of the bug-men, the outlines of the hidden dome began to appear with fascinating symmetry. The completed group of wells forms an ellipse, perfectly egg-shaped. This scientifically developed field now supplies San Francisco and neighboring cities with natural gas.

Fortunate discoveries, indeed, are these new scientific aids; for hidden in such blind formations, with no outward indications of their structures, lie the great oil sources of the future. "Ninety per cent of the fields of today," a leading geologist said recently, "are on structures as plain as the nose on your face. The old-fashioned geologist usually located his wells upon an outstanding dome-shaped prominence or ridge of hills, or else in the vicinity of a fault where telltale oil seepages told an unmistakable story. The geologist of today faces plenty of hard work, for such plain guides will not be at hand in discovering the fields of the future. He will need the help of the best scientific methods."

Even as he spoke, brand-new methods and theories were being tried in the laboratories and workshops of inventors and experimenters. Not far away, two men stood upon the derrick platform of an old oil well, listening intently to the sounds that came to them through wireless-type headphones. A third man slowly paid out a light steel cable into the hole.

To the ears of the listeners came a regular, measured clanking; for 5,000 feet below, a miniature electric hammer was tapping the steel casing with regular, rhythmic blows. As the strange instrument passed downward, the listeners jotted down notes, while the third man read off the depths from an indicating dial actuated by the moving cable.

This remarkable device, still in the experimental stage, is the invention of Haskell M. Greene, of Santa Fe Springs, Calif. With it he explores oil wells to determine whether the casing is tightly set in solid rock, cemented, or free. He hopes to be able to go into old wells whose drilling records have been lost, and determine where *(Continued on page 95)*

Loudspeakers Page Hospital Doctors

Eighty-five loudspeakers, two of which are shown at left and below, page doctors in a New York hospital. Control knob, left, governs volume of speaker

No TIME is lost in calling any particular physician in one of New York's big hospitals, where a new paging system has just been installed. When a telephone call for a doctor is received at the central switchboard, it is referred to an operator who, finding the doctor is in the hospital, repeats his name before a microphone. Eighty-five loudspeakers in the corridors and ante-rooms of the hospital broadcast the message. Wherever he is, the doctor takes the call at the nearest telephone. Western Electric engineers, who installed the system, provided controls for adjusting the volume of the loudspeakers.

Three tiny fuses, used to guard delicate instruments, are shown above. At left, human hair and wire in fuse are magnified 100 times for comparison of sizes

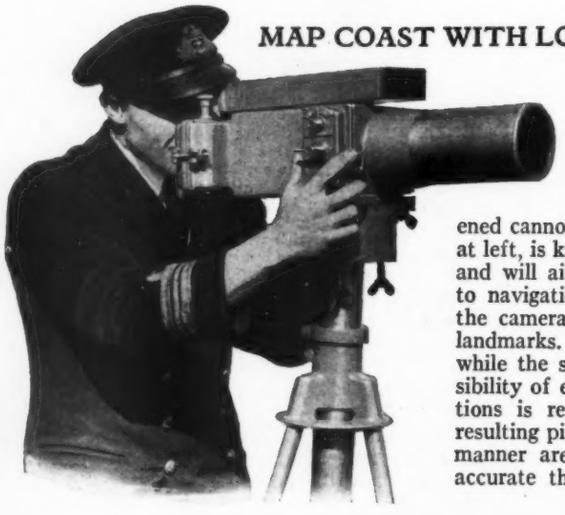
TINY FUSES TO GUARD DELICATE INSTRUMENTS

HOUSEHOLD fuses are giants compared with a series of miniature fuses recently placed on the market. The smallest of these is made of platinum wire one thirtieth the diameter of a human hair. It is so delicate it cannot be seen by the naked eye. A current exceeding a hundredth of an ampere will cause it to fuse and break the circuit. The new fuses are designed to prevent harmful overloads in radio tubes and in delicate electrical measuring instruments and other equipment operating in the range below one ampere.

SPECIMENS WHIRLED ON DISK IN MICROSCOPE

TINY cells are whirled to destruction, while powerful lenses magnify the miniature cataclysm, in a new microscope centrifuge perfected by Dr. Gustav Fassin, University of Rochester optical expert, and shown below. Specimens placed on a whirling disk within the instrument are spun at a speed of four miles a minute. By catching glimpses of the cells as they become distended and break, scientists learn more about their composition. The centrifuge will help the fight on germs.

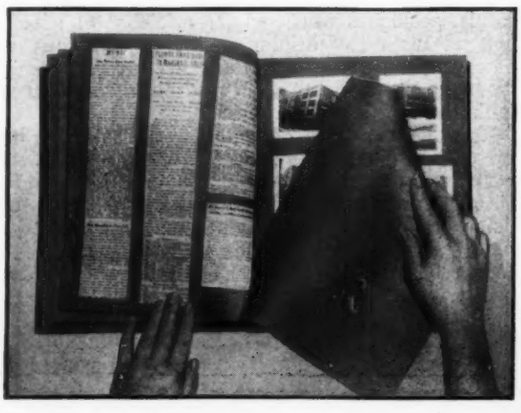
MAP COAST WITH LONG-RANGE CAMERA



AN ODD instrument aboard the British survey ship *Challenger,* which bears a party of explorers on a nine-month trip to chart the Labrador coast, looks like a foreshortened cannon. The device, shown in action at left, is known as a hydrographic camera and will aid in mapping rocks dangerous to navigation. A long-range lens permits the camera to be sighted against distant landmarks. Photographs will be made while the survey is in progress, and possibility of error in the surveyors' observations is removed by checking with the resulting pictures. The maps made in this manner are expected to be more nearly accurate than any previously made.

NEW SCRAPBOOK CAN'T BULGE

CLIPPINGS pasted in a scrapbook, recently put upon the market by an eastern manufacturer, do not make it bulge. Every other page is perforated so that it may be torn out as the preceding page is pasted up, as shown in the photograph at right. This compensates for the thickness of the clippings and permits the filled volume to lie flat, thus improving its appearance and adding to the ease with which it is handled.



Blimp Carries Vertical Antenna for Radio Broadcast

TRAILING from the bottom of a baby blimp 1,500 feet in the air, a 500-foot antenna recently sent out experimental broadcasts near Pittsburgh, Pa. Engineers of Station KDKA, the pioneer radio station that first broadcast popular programs in America, recently conducted the tests to determine the effect of a long-sending aerial operating vertically to the earth instead of parallel to it, as is the case with conventional broadcasting equipment. Programs sent out from such aerials, it has been suggested, would reach receivers more clearly and with less interference. If the tests are successful, further experiments will be made with a larger balloon at a higher altitude. In the first trials, the aluminum guy wire that served to tether the blimp was also used to convey the program to the antenna. The photograph shows the blimp about to be launched.

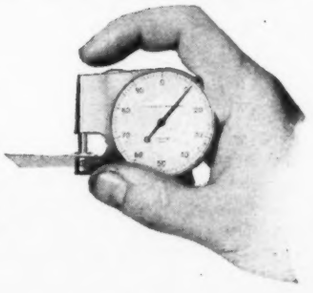
STUDY FISH WITH SUBMARINE SLEDGE

TO AID in surveying the plant and animal life of Lake Constance, on the German-Swiss border, scientists have devised a contrivance known as a submarine sledge. Trailed on a wire beneath a launch, the sledge scrapes along the bottom on ski-like runners and collects specimens in a net. It is drawn up when full, and the catch is spread out for study. The survey will help increase fish in the lake.

Submarine sledge, on top of the survey launch that tows it, is being made ready for submergence

VEST POCKET THICKNESS GAGE

SO COMPACT it may be tucked away readily in a vest pocket, a new gage makes the measurement of small thicknesses as easy as telling time by a watch. The jaws are opened by a wheel beneath the index finger, and close automatically over the object to be measured when the wheel is released, as shown in photo at right. A revolving pointer stops at a point on the dial indicating, in thousandths of an inch, the thickness of the material being measured.



UNKNOWN MAYAN ARTIST CARVED BIG MONUMENT

FOUR centuries or more ago, a Mayan sculptor in Guatemala laid down his tools and surveyed a stone monument he had just completed. Twice as tall as a man, it depicted a Buddha-like figure seated in a niche. Illustrated above, this monument, and other rare treasures of early Mayan culture, have just been unearthed and forwarded to the University of Pennsylvania Museum at Philadelphia, Pa. Descendants of the Mayas are numerous today in Guatemala, but the lore of their ancient craftsmen is virtually lost.

PLANT GROWTH SPEEDED IN Midget Gardens

By Walter E. Burton

This concentrated garden, consisting of one trough above the other, was invented in Florida where it is in use. The plants are watered and fertilized by the same system. The arrangement insures the same amount of sunlight for each plant no matter what trough it's in

PLANT wizards and inventors have succeeded in reducing the size of gardens to a point where products formerly requiring an acre or two of space, can be raised in the back yard, or even indoors.

Several paths have been followed in reducing garden size without lowering the yield. At the moment, some of these have not been extended far beyond the experimental stage, but they give indications of great possibilities in the near future. Some need only general adoption to make them successful in a big way.

A Miami, Fla., inventor's idea of a vest-pocket garden takes the form of a series of patented wood troughs into which is built an irrigation and fertilizing system. Combining watering and fertilizing operations, without waste, makes his method particularly desirable.

The inventor, George Leon White, claims a 1,500 percent gain in space. In other words, he can raise on one acre crops normally requiring fifteen acres.

The sample trough system shown in the photographs can be expanded to cover as much ground as desired. The unit measures six feet long, one foot wide, and about three and one-half feet high. It contains 125 strawberry plants, thriving in twenty-four square feet of soil.

Each of the troughs has a false bottom that, along the intersection of the two sidepieces, helps form a narrow canal through which fertilizer-laden water can run. The water is poured into a compartment at one end of the top trough. Thence it runs to the other end of the trough, spills through an overflow tube into the second trough, continues to the opposite end, and into the next trough and so on until the plants in every trough are watered.

This continues until excess water finally flows into a container from which it can be dumped back into the top trough. In this way, none of the fertilizing material is lost. The water, as it flows along, comes into contact with the soil, which soaks it up and makes it available to the plant roots. The unit shown has been designed for use in sunrooms, on porches, and in yards.

The inventor, by making plant food directly available to the roots, has speeded up the growing process, in addition to gaining a saving in space. His trough units can be built to any height. A large installation can be watered by a windmill and tank arrangement.

In a compact box garden, like the one pictured here, vegetables are sprouted for winter use

Almost any plant, if not to big, can be grown in the troughs. This includes onions, radishes, strawberries, celery, beets, turnips, and some varieties of beans. The troughs can be arranged so that plants in both sides receive the same amount of sunlight.

The multiple-trough idea is a refinement of the old strawberry barrel or earthenware pot. If holes, an inch or so

in diameter, are bored at evenly-spaced points around the sides of a barrel, and the barrel filled with earth, strawberry plants, and various other garden products, can be grown successfully. The barrel can be watered by means of a funnel fitted into the top. A group of such barrels provides a comparatively large growing area on a limited amount of ground.

Experiments are being conducted with concrete barrels or cylinders several feet high. These cylinders have holes over the curved surfaces, through which plants grow. Water can be introduced at the top of the cylinders.

Widespread interest has been created by the wonders worked with concentrated plant food, of which certain plant pills are one form. Such food makes possible the ultimate in garden compression.

A California scientist has developed a chemical preparation which, when carried in solution in water, makes it possible to raise cabbages, celery, beans, and other garden products without the use of soil. The vegetables are grown in shallow troughs, sawdust and excelsior being used to hold them in position. So great is the concentration achieved that plants thrive when crowded so closely that they touch each other. A plant can be moved from one trough to another without disturbing its growth.

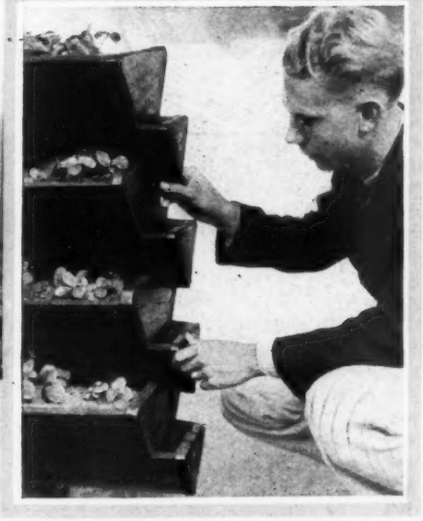
Other tricks of plant magic have been performed by Dr. J. T. Charleson, industrial chemist. Dr. Charleson has succeeded, by using a special preparation, in doubling fruit yield and trebling the production of flowers on a single plant. In addition to this two- or three-fold gain, his plant food, which is soluble in water, can be used in troughs or any other arrangement for holding growing plants.

Investigations made by universities and commercial establishments, Dr. Charleson points out, have indicated that there must be perfect coördination of chemical elements to make a plant behave properly. In addition to the elements contained in ordinary fertilizers, there must be certain activators, or substances that act more as stimulants than as foods. Among the necessities for maximum yield of fruit or flower are phosphorus, potassium, nitrogen, boron, and manganese. They must be properly blended, or the plant will suffer.

Dr. Charleson's plant food takes a granulated form that can be dissolved in water, one quart making fifteen quarts of stock solution which is then diluted five to one before being applied with a sprinkling can. He perfected it primarily for use with water plants, but tests have shown that it is equally useful for vegetables, rose bushes, rock garden plants, and the like. A gallon of the stock solution is enough for seventy-five rose bushes, or 1,000 square feet of garden.

These tropical water lilies, blooming in a northern climate, show how plants respond when given prepared food as shown in photo

Water hyacinths, right, are blossoming in November in an Ohio greenhouse as the result of treating them with plant food



In watering and fertilizing plants, grown in the trough garden shown on the opposite page, the mixture is poured into a tank, above, and drains to each trough in turn as is shown at the right

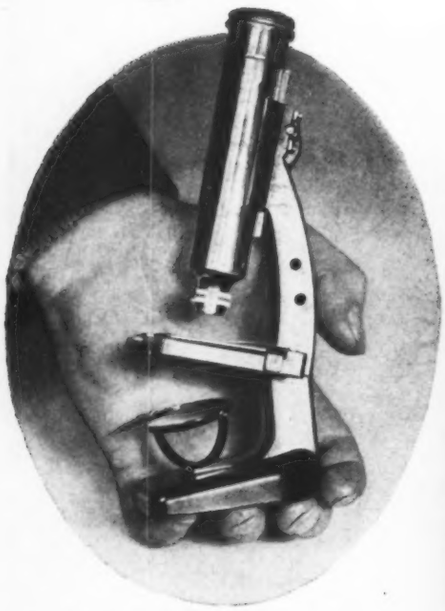
By means of the plant food, he has made water lilies and other plants bloom out of their usual season, and has produced flowers on aquatic plants that bloom so infrequently as to make the occasion a noteworthy event. In addition, the individual flowers generally are larger than normal. The inventor can, by varying the composition of his food, produce almost any desired effect, such as a plant that is all foliage and no flower. In fact, this is what ordinary fertilizers are inclined to do in many cases, according to Dr. Charleson.

The U. S. Department of Agriculture recommends that an indoor sprout garden be maintained for providing vitamin-containing food during winter months when fresh garden vegetables are scarce. Nothing could be simpler or more compact than such a garden. The seeds, beans for example, are placed in a layer between several thicknesses of cheesecloth which is kept moist. Or the seeds can be spread on a plate and kept covered with damp cloth. In addition to beans, the various cereal grains, like corn and oats, can be sprouted. The products of a sprout garden are cooked as greens, there being little or no waste because roots and all are used.

The Department of Agriculture has done extensive research work in connection with the effect of daylight on growing plants. It has been found possible to change the flowering or fruiting period of many plants by prolonging or *(Continued on page 96)*

Hunting Water Life

MAKING A NET TO SNARE ANIMALS AND OR SEA WATER—HOW TO STUDY THEM



This new baby microscope is intended for amateurs. It magnifies up to 350 times

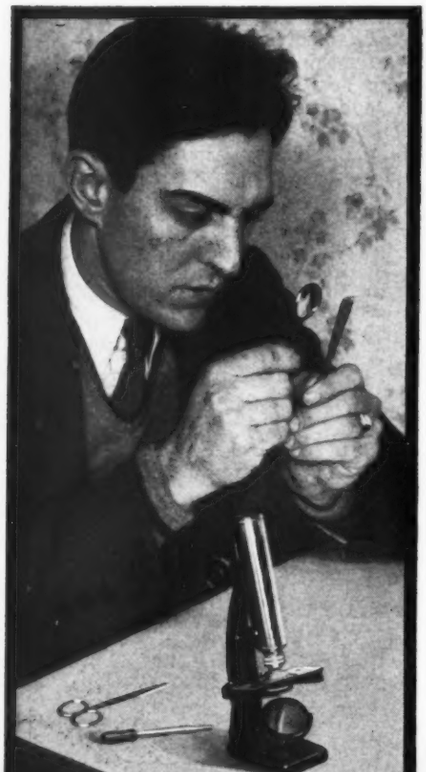
By
Borden Hall

ONE is never even dimly conscious of the teeming life in the world that is crushed under one's feet or that swims and swirls through the depths of a pond until one views it through the lens of a microscope capable of multiplying images 300 times or less.

The beginner with the microscope is so appalled at the multitude and variety of living and non-living things that may be brought to the stage of his instrument that often he is unable to decide where to begin his investigation. During the winter time we have the crystals of salt, bread, mold, lice from plants, leaves, coal, hair, paper, bits of vegetables, and a host of other common household objects that offer unending sources of pleasure and instruction.

In the summer, nature offers a new world to explore. In former articles mention was made of the multitudinous forms of life to be found in pools of stagnant water. The subject was barely touched upon, however, and now we shall tell how specimens may be gathered from them and describe the new equipment we will need.

First, the amateur microscopist must learn how to pick out the jungles and the open veldt in which to do his hunting. An ordinary mud puddle that has been standing in the warm sun for several days is a likely hunting ground, especially if it lies in a wind-swept spot to which pollen and other life-bearing particles have been borne. The running brook or the lazy river or creek also will yield specimens well worth study. But the best place of all is



A small hand lens is used to examine bits of underwater vegetation in search of specimens to be viewed later in the microscope

a stagnant pool, where you can find a larger number of curious specimens of animal and vegetable life than in any other spot accessible to those living inland.

A FEW months ago, I suggested that we hunt microscope specimens with an ordinary, wide-mouthed bottle tied to the end of a string and dragged along the bottom of a pond. The surface of the bottom contains the most interesting specimens, especially in pools and ponds that are covered with green scum. Although the bottle makes a good hunting tool, a far more efficient instrument is the little net pictured on the opposite page. This is made of muslin with a small pill bottle attached to the bottom by a heavy rubber band. When this net is swept through the water and brought to the surface, the fabric will imprison the specimens and they will be washed into the little vial by the movement of the water.

Those who live near the seashore have available a theater of wonders that in many ways rivals the stagnant pool in the country. For instance, wondrous little specks of life called foraminifera will often be found in the ripples of sand left by the tide. These are small shells of single-celled animals and they assume a wide variety of forms. Many forms of life also are attached to rocks and weeds that grow in sea water. If we take a few bits of seaweed home, making sure to keep them in sea water on the way, we shall find they contain a number of interesting objects; tiny creatures, for example, that thrust forth little tentacles to entangle other minute forms of life.

NO CASUAL examination of this kind, however, is adequate, for if the scene is to be enjoyed in full, we must develop a special method. The seaweed must be held in a trough or cell filled with sea water and viewed with a low-powered objective (the lens at the bottom of the microscope tube.) From the accompanying photograph, you can see how easily this useful little water cell may be made. It is not only valuable for peering at the strange life that fastens itself to seaweed but also for examining other specimens that live on the various forms of vegetation in rank ponds and pools.

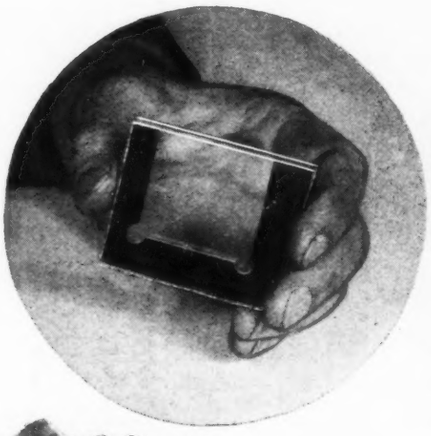
Obviously it would be too much trouble to run down to the seashore every time

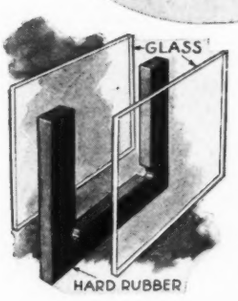
Before drying a specimen you wish to study, it is placed in a test tube and washed in alcohol, being cleaned by a brisk shaking

A flat specimen sometimes can be examined more easily if it is placed between two slip glasses that have been thoroughly washed

FOR YOUR Microscope

PLANTS FROM PONDS IN TINY WATER CELL





WATER CELL FOR SEA LIFE

A water cell, made of two glass slides fastened together as shown in drawing at left, affords a convenient way to place living sea specimens under a microscope

The inset drawing shows how a hunting net is made easily and cheaply. When fitted with a three-foot handle, it can be used, as the illustration suggests, in gathering pond life

we wish to examine specimens or make new collections. To get around this problem, we establish a miniature sea right in our own homes. It can be done for a few pennies. We simply buy a small aquarium, provide it with sand, and fill it with sea water, being sure to add sea plants to bring about aeration of the water so that our specimens can live in it. In a short time, we can have a teeming community of many sorts of sea animals.

WHILE we are considering sea life, let us not forget the stunning varieties of colors and tints that are provided by fish scales of various kinds. The specimen chosen must be small and thin so that it will be translucent. These scales are easily mounted. Transparent parts of cray fish, crabs, and other crustaceans offer beautiful studies in animal structure.

We must also provide a permanent home for our specimens of pond life. To do this we arrange a fresh-water aquarium into which plant life must go to supply the needed, life-giving oxygen. Unless the water has a certain amount of oxygen dissolved in it, our specimens soon will die. It is easy to place subaqueous plants in some mud in the bottom of the aquarium, pressing their roots in and then pouring the water over them.

Peering into pond water, we find those interesting, threadlike formations of vegetable matter called algae. To discover them, we use a microscope slide with a slight depression ground in it to hold water. When we find a specimen, we transfer it to a flat glass and use a more powerful objective. This transfer is made to facilitate examination with the more powerful glass. It has been noted previously that the higher the power of the objective used, the closer we get to the object. Algae are like beautiful strings of beads, the beads being vegetable cells such as those that go to make up the entire plant world. Here, however, nature, for some strange reason, has strung the cells out end to end.

Botanists classify this strange life as Zygnema and Spirogyra. The latter branch of the family is the more interesting. It is plentiful in slower streams, hanging from the stems of weeds in long streamers. In stagnant pools, it grows by itself in scummy masses. Each cell of this plant has its bright green spiral chloroplast, a form of chlorophyl which is the substance that gives plants their green color and their ability to make sugar from water and carbon dioxide through a process called photosynthesis.

A SPECIMEN is stained with a weak solution of iodine. In an earlier article, I told how certain dyes are used to color specimens so that their less colorful portions will be more easily seen. When this tiny plant is treated with iodine, you can see in each cell the nucleus, the nucleolus, and the protoplasm as yellow masses.

No thrill is greater to the microscopist than that of witnessing the mysterious process of creation. It is only through the microscope that this is possible) We can see it in connection with spirogyra. Here we may see two filaments coming together. The threads unite and the filaments lose their normal appearance. Watching closely, we note further that the chloroplast loses its normal form and the cell walls are absorbed. Finally the contents of the cells of one of the threads pass into the cells of the other. In a short time, the blended contents will produce spores from which new plants will develop.

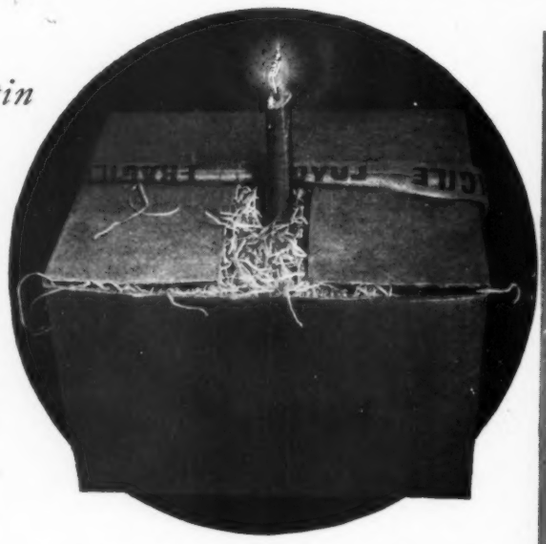
ANOTHER amazing method of reproduction is revealed by the spinning globes of Volvox Globator. High power is not needed to discover them for they measure about one twentieth inch in diameter. To discover them, we use a water cell, dropping the microscope to a horizontal position and slipping the cell under the stage clips in the same manner as that used for an ordinary slide. Some of the water is transferred to a slip glass with a ground depression.

At first we may not succeed in capturing the wily globator but on the second or third attempt, we shall succeed. Here is a wonder of wonders—life that takes the form of balls within balls. Looking closely, we find that the outer ball has two lashes which function like the fins on fish in bringing about locomotion. If we are patient, we can see the outer, or mother ball, grow old, peel off, and slip away to its aquatic grave. This exposes the second layer which takes up the duties formerly discharged by *(Continued on page 84)*

Tricks of Firebugs

EXPOSED BY POLICE EXPERTS

By Robert E. Martin



A candle, burning at the rate of one inch an hour, is set in a box of excelsior and left to fire the house, giving the crook time to establish an alibi

ITS engine throttled down, a black touring car swung noiselessly into the driveway of an unoccupied house on Long Island, thirty miles from New York City. Two men hastily entered the building carrying bundles and cans. It was three o'clock in the morning. The owner was hundreds of miles away on his vacation.

Twenty minutes later, neighbors tumbled from their beds at the sound of a terrific explosion. Through its shattered windows, they saw the vacant house lighted up by a plume of yellow flame flaring half across the basement from a broken gas pipe. Two dark figures were picking themselves up from the front yard outside one of the windows. They scrambled into the touring car, backed swiftly into the street, and raced away.

In less than ten minutes, Sergeant Albert V. Pitt, head of the Bureau of Public Safety and arson expert of the Nassau County Police, was on the spot. The gas had been turned off and the danger of fire was over. Inside he found gasoline-soaked rags stuffed in every corner of a downstairs room. The furniture was saturated. In fact, the firebugs had done their work too well.

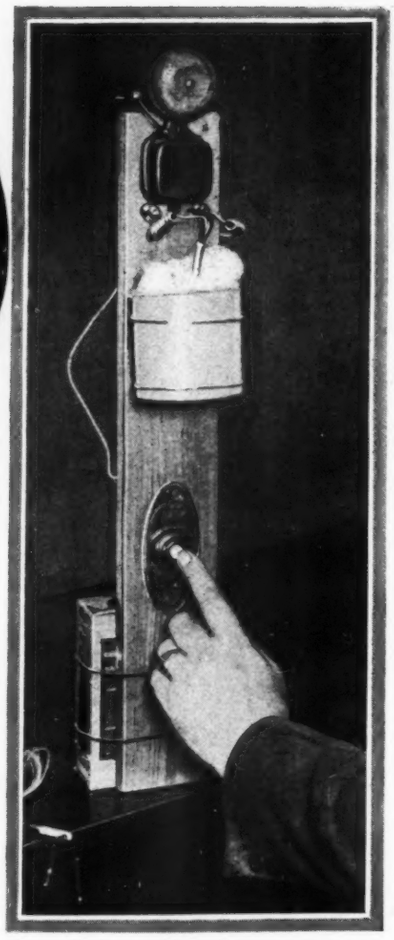
They had spent so much time soaking the rugs with gasoline that the fumes had formed an explosive mixture in the room. The instant the match was struck, a blast hurled the men through a window, twisted the house on its foundation, and cracked off a gas pipe near the basement floor. The escaping gas caught fire, flaring like a blowtorch. But it was so low in the basement, it did not set fire to the house above. The giant puff of the explosion, which shattered the windows, also blew out the fire in the gasoline-soaked room. Strangely enough, too much gasoline had saved the house from flames! It also preserved intact all the evidence of the plot to burn the house.

Imprinted in the dirt of the driveway, Pitt found the tiremarks of the arson car. They showed the front wheels had tires of different treads. Making plaster casts of the marks, he checked up on every touring car in town. Only two machines had treads that matched the imprints. One belonged to a taxi driver who proved he knew nothing of the plot. The owner of the second car was found in bed, burned and bruised. He confessed, implicating his companion and the owner of the house. Pressed for cash to prevent foreclosure on his store, the owner had hired the men to burn down his insured house while he was out of town. All three men were given prison terms.

Arson, today, is at an all-time peak in the United States. America is the home of the incendiary. More fires of a suspicious nature occur here than in any other country in the world. Day and night, the firebug and the pyromaniac take nearly $300 a minute from the pockets of American home owners. Gangs, thriving on present business conditions, are burning buildings for stated fees. Their work raises the rate which everyone has to pay for fire protection.

An expert told me recently that more damage is done by one incendiary fire than by a dozen ordinary ones. In arson, everything is planned to help the fire make headway. More than half of all the firemen who lose their lives, die in flames started by the incendiary torch. A large proportion of the 10,000 people who perish annually in burning buildings owe their deaths to fiendish firebugs who burn for profit, thrill, or revenge. Fighting arson is a national problem, now complicated by the ingenious tricks and the elaborate mechanisms used.

Only a few days ago, a gang was trapped in the act of setting up a fire machine, an involved device of coils and containers, in an eastern hotel room. The arrests followed a week of day-and-night watching from a nearby church steeple after Chief Fire Marshal Thomas P. Brophy, famous firebug hunter of the New York City department, had received a tip from the underworld that the torch gang intended to fire the building.

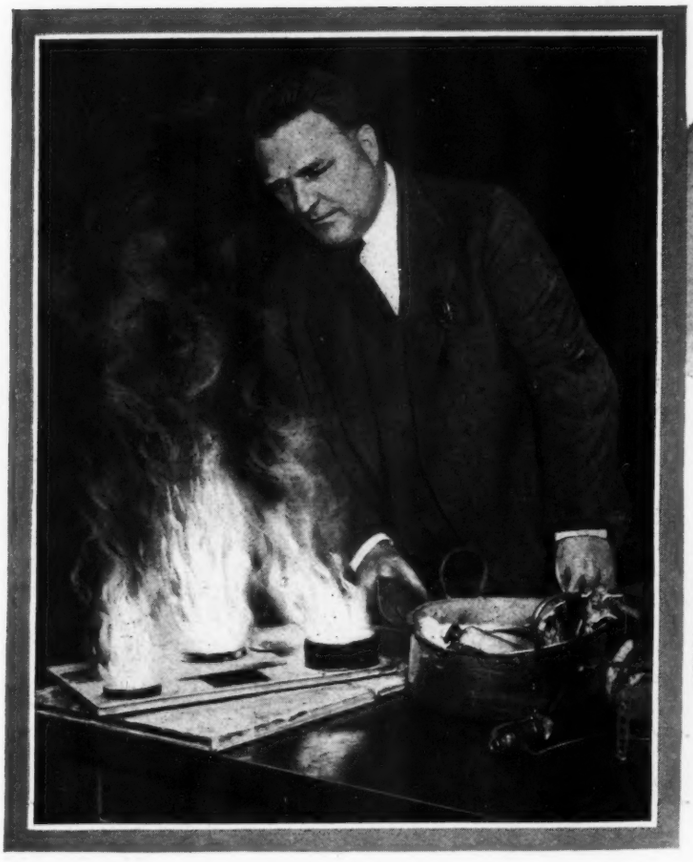


Wire and blasting cap are attached to a doorbell so cap is discharged when the button is pushed, thus starting a fire

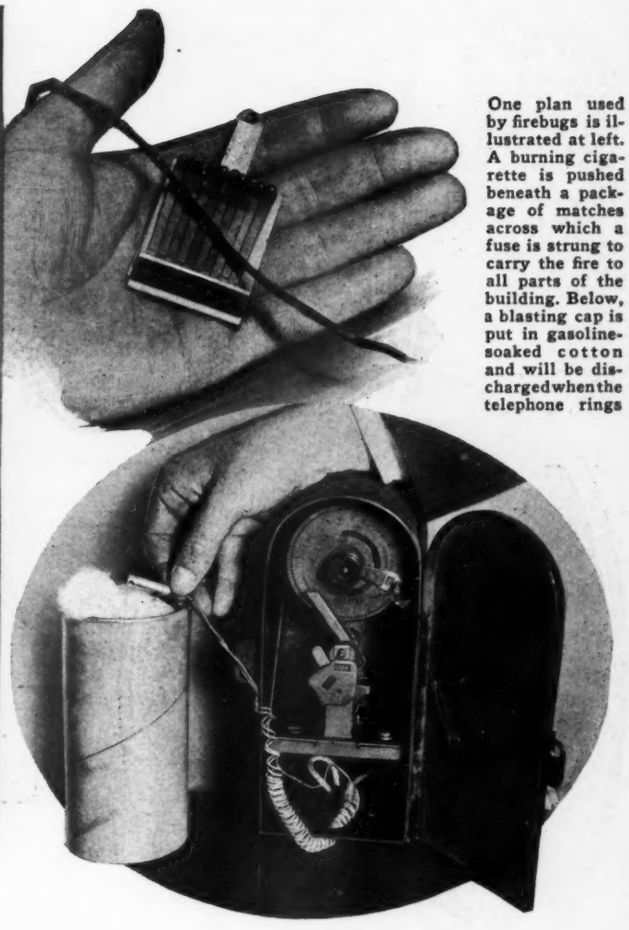
One of the queerest cases Brophy has had in recent years was an incendiary fire in a school for deaf mutes. He had to question each of the 250 persons in the building. The questions were asked by the superintendent of the school in sign language and each child wrote the answers on the blackboard for Brophy to read.

A fire of mysterious origin recently gutted a $40,000 home on Long Island late at night. At the time, the owner was away on a business trip and his family was in Europe. The house was heavily insured. No one was seen near the place on the day of the fire.

By a brilliant bit of detective work, Sergeant Pitt uncovered evidence of an almost perfect plot to burn the building and cheat the law. When he examined the ruins, he noticed something curious. Clinging to the remains of the telephone, was a short piece of wire with a bit of



These waxed paper containers, which are being burned as a proof of arson, were taken from a building in which forty-two of the same kind had been filled with gasoline and scattered about to spread the flames



One plan used by firebugs is illustrated at left. A burning cigarette is pushed beneath a package of matches across which a fuse is strung to carry the fire to all parts of the building. Below, a blasting cap is put in gasoline-soaked cotton and will be discharged when the telephone rings

Concerted Fight Made on Arson as Criminal Fires in United States Cost Over $5,000,000 Each Year

melted copper at the end. Pitt called the local telephone exchange. He learned that a long distance call had been put through to the house on the night of the fire, some ten or fifteen minutes before the flames were noticed.

The owner had attached a wire, ending in a small blasting cap, so it would ignite a container of gasoline when the telephone rang. Then, after midnight, he had called up his own unoccupied house from Chicago, thus touching off the fire which practically destroyed the building. The fact that he was a thousand miles away at the time of the fire, he thought, would completely eliminate him from suspicion.

In another instance, an electrical contractor rigged up a similar wire and blasting cap and attached it to his doorbell. Then he sent himself a telegram from a distant city, timing it so it would arrive in the early morning hours. When the messenger pushed the button, the fire started inside. However, it was not noticed until twenty minutes later when the flames were making rapid headway.

A third application of a wire and a blasting cap to the work of the firebug recently endangered the lives of forty people living in apartments above a block of stores in a western city.

An electric clock, of the type that automatically turns electric signs on and off, was attached to wires in a trash-filled basement. The cold-blooded plotter set it to switch on the current at 1:30 A.M., igniting strips of celluloid and a can of gasoline. In addition, he left an electric fan running to drive the flames through the cellar, hastening their work of destruction.

All these carefully-planned and fiendish preparations were upset by an aching tooth. At 1:30 A.M., when the clock closed the switch, a man living overhead was walking the floor with a swollen jaw. He smelled smoke as soon as the fire started. His quick alarm brought the fire department in time to check the flames before they left the basement.

Not infrequently, some strange unforeseen circumstance, like that throbbing molar, will trip up an arson plot and result in extinguishing the fire in time to preserve evidence against a plotter.

One of the most curious instances of the kind occurred a few years ago in New York City. A baby, sleeping in its crib, was awakened soon after midnight by drops of hot water falling on its face from the ceiling. The cries of the child aroused the family of seven persons just in time for them to escape from the burning building and sound the alarm. A pyromaniac had set fire to the empty apartment above. The flames had melted a water pipe and this water, seeping through the floor at the exact spot above the infant's head, had acted as the alarm that saved their lives!

The mental disease that makes a pyromaniac set fires is still a mystery to psychology. In a number of cases, these dangerous unfortunates have been made sane and happy by being allowed to stoke prison furnaces. This satisfied their abnormal craving to be near leaping flames.

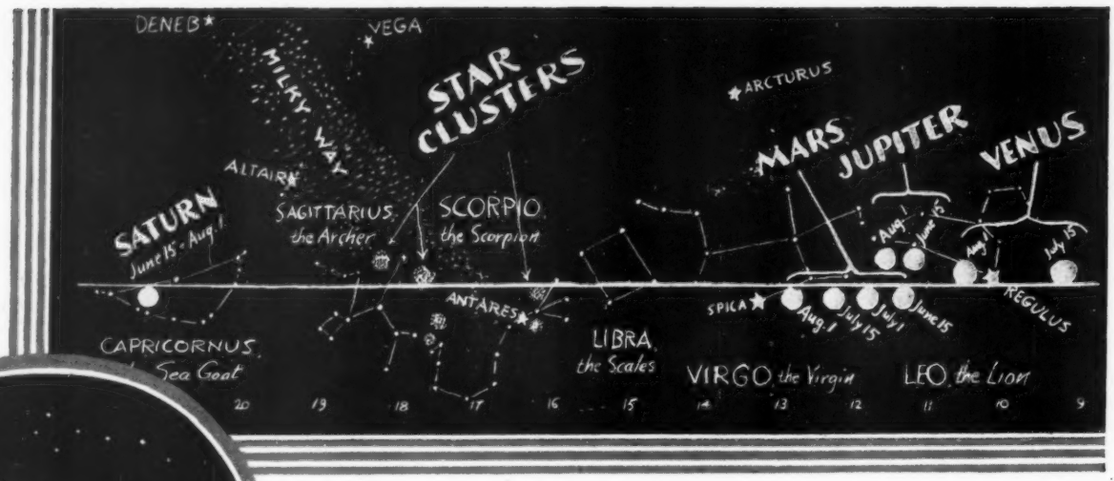
Imagine a fire department made up of pyromaniacs! That was almost the situation in one case solved by Sergeant Pitt. In a Long Island town, where the local fire department had won first prize in a competition among volunteer organizations, mysterious blazes began to appear in rapid succession. In less than a year, the town had more than a hundred fires. Arson was suspected, but definite clues were lacking.

One night, a man troubled with insomnia looked out the window and saw a sedan with two men in it drive past out of a dead-end road. A few minutes later, in the direction from which the car had come, flames shot up from an empty house. The man had seen the car and its occupants clearly enough in the moonlight to give a rough description of them. The description fitted two members of the local fire department, one an ex-captain, the other a deputy-chief.

Working fifty-three hours without sleep, Pitt obtained confessions from more than thirty members of the fire department. Twenty-three indictments resulted, with fourteen defendants pleading guilty. In *(Continued on page 96)*

TIME-TABLE OF STAR EVENTS

The sky map, right, shows various positions of planets and stars through the summer months. Several star groups that can be seen with an opera glass are indicated. Reference to it will help you keep track of the racing planets from month to month



In observing the stars with a field glass or an opera glass, it will help you to put it on a tripod, as shown

What You Can See In Starland *with an* OPERA GLASS

THRILLING contests of speed, in which the planets, the moon, and the sun are spirited rivals, are constantly being run along a narrow sky track that goes completely around the heavens.

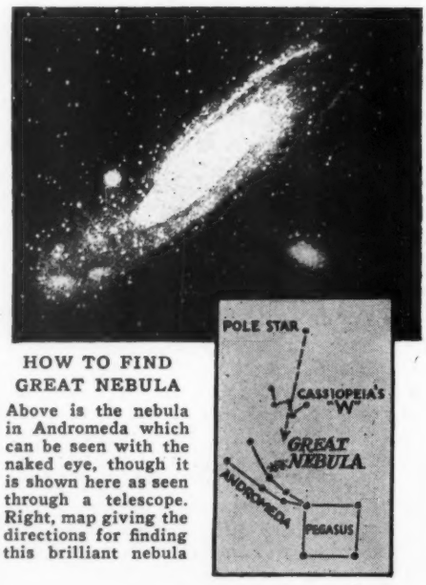
Once you have learned to trace the course of these mighty racers, and how to know them at a glance, you will have endless delight in watching their sprints from month to month and year to year.

Fortunately, the summer nights this year offer a splendid opportunity to get acquainted with the big shots, Mercury, Venus, Mars, Jupiter and Saturn. They will all be coursing along the part of their track visible to us during June, July, and August.

Let us begin by tracing out a part of the race track, making use of the star landmarks we learned last month with the aid of our chalked umbrella and the bow ruler we invented (P. S. M., June, '33, p. 42).

During the early evenings of June and July, the dipper hangs down at the left of the polestar. Its handle points up toward the zenith. By prolonging its curve, you find brilliant Arcturus, high in the sky. A line through the two stars in the side of the bowl next the handle, prolonged about fifty half-inch degrees westward, finds Regulus, the chief star of the group called Leo, the Lion. Regulus gives you a point exactly in the middle of the sky race course. It appears in the westward sky after sunset, about sixty degrees from Arcturus.

To find another point in the track, imagine Arcturus and Regulus as lying at two corners of a big right-angled triangle. At the right angle, about thirty degrees on your bow ruler southward from Arcturus and fifty degrees eastward from Regulus, you will see a bright star. This is Spica, the wheat ear in the star group called Virgo, or the Virgin. Spica also marks a point on the path of the planets. By joining Regulus and Spica, we have surveyed a section of our celestial race track.



HOW TO FIND GREAT NEBULA

Above is the nebula in Andromeda which can be seen with the naked eye, though it is shown here as seen through a telescope. Right, map giving the directions for finding this brilliant nebula

Along this line pass all the members of our solar system including the sun and moon. When you find Spica, you will see, in the part of the track extending toward Regulus, two of our sky racers right there now. They are Jupiter and Mars. On the evening of June 4, they are neck and neck. Jupiter is the brilliant one slightly to the northward of Mars, which you will know by his more reddish color.

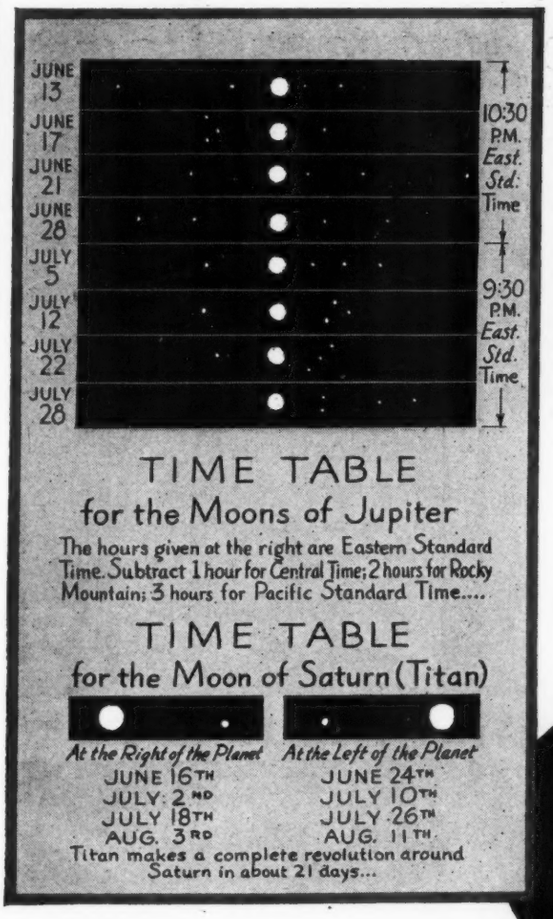
If you watch these two planets through succeeding evenings of June and July, you will see Mars pass Jupiter, and leave him far behind. The position of each planet is indicated on the blackboard chart at the head of this article. Note that the course of the planets along the track is always eastward.

Your observation this summer of the movements of Mars and Jupiter will be more interesting if you watch how, once each month, the swiftly racing moon overtakes and passes both planets. The moon will draw abreast of Jupiter on June 29, and will pass Mars the next night. On July 26 and 28, the moon will again race and beat these planets successively.

Now let us trace the heavenly race track across the rest of the summer sky. We will then be ready to examine some of its points of interest with an opera glass and a binocular.

Exciting Races in the Heavens—Faint Dots that Turn into Great Clusters of Stars—Learn How to Study Moon's Features

By GAYLORD JOHNSON


JUNE 13
JUNE 17
JUNE 21
JUNE 28
JULY 5
JULY 12
JULY 22
JULY 28
10:30 P.M. East. Std. Time
9:30 P.M. East. Std. Time
TIME TABLE
for the Moons of Jupiter
The hours given at the right are Eastern Standard Time. Subtract 1 hour for Central Time; 2 hours for Rocky Mountain; 3 hours for Pacific Standard Time....
TIME TABLE
for the Moon of Saturn (Titan)
At the Right of the Planet
JUNE 16TH
JULY 2ND
JULY 18TH
AUG. 3RD
At the Left of the Planet
JUNE 24TH
JULY 10TH
JULY 26TH
AUG. 11TH
Titan makes a complete revolution around Saturn in about 21 days...

four moons when they are favorably situated, and when there is no moonlight to dim them.

With a field glass, or binocular, magnifying eight or more times, you will have no difficulty in seeing all of the moons, unless they are behind the planet or so close to his side that they are lost in his glare.

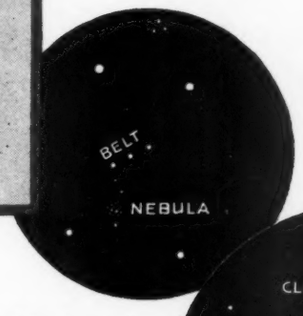
If you wish to observe Jupiter's satellites in a serious way send to the Government Printing Office, Washington, D. C., for a copy of The American Ephemeris and Nautical Almanac for the year 1933, price $1.75, clothbound. It gives the position of Jupiter's moons for every day in the year, together with much detailed information about the position and movements of the planets, moon, and sun.

When you catch your first glimpse of Jupiter's moons, you will be able to imagine the kick Galileo got when he saw them for the first time in history, on January 7, 1610. His homemade telescope, through which he discovered them, was only a one-eyed opera glass, yet with it he caused a revolution in the world's ideas of the universe.

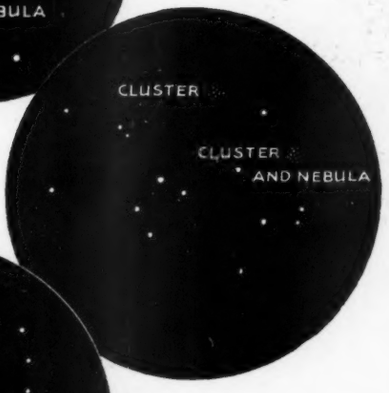
Mars offers no features within the reach of a field glass, but a good one will show Titan, the largest moon of Saturn. You must wait, however, until you have a telescope magnifying 100 or more times before you can see in detail the other moons of Saturn and its marvelous system of rings.

When you have found the star Antares in the Scorpion, take your opera glass and examine the region immediately around it. Just below and to the right of this smoldering red star, you will see a nebulous speck. Examined through a more powerful field glass, it is seen to be not a single star but a closely compacted cluster of tiny stars.

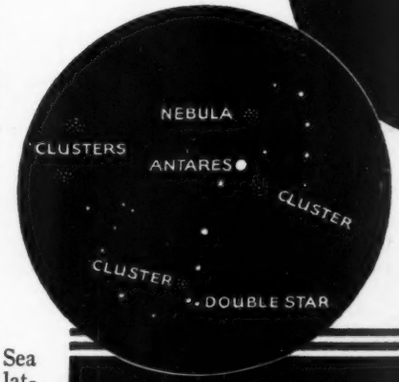
This, by the way, is a good way to proceed in all your star observations. Have an opera or field glass with a wide field, *(Continued on page 94)*



Map, left, is of the famous nebula in Orion. It will not be visible until next winter. At that time, your opera glass will find it as second "star" in Sword of Orion, under the Belt



The map, right, shows the star cluster in The Archer. Exploring this region with an opera glass will reveal groups of tiny suns



Star clusters in The Scorpion, left, are faint dots to the naked eye, but an opera glass will plainly reveal that each one consists of many tiny stars

The line joining Regulus and Spica runs eastward through the four additional star groups outlined on the blackboard chart. Libra, the Scales, is inconspicuous but Scorpio, the Scorpion, is easy to recognize. It is the only star group that looks much like the object for which it is named. You will find it directly south at nine o'clock during the month of July. The path of the planets, or ecliptic line, passes directly north of Scorpio's brightest star, Antares. Its reddish color explains its name, which means rival of Mars. You will have an opportunity to compare them, when, about October 1, Mars will be approaching the star group of Scorpio, and will therefore be near Antares.

The remaining summer star groups along the planets' path, Sagittarius, the Archer, and Capricornus, the Sea Goat, have no brilliant stars, but the latter is made conspicuous this year by the presence of the slow-moving planet Saturn. It requires twenty-nine and one-half years to complete the whole circuit of the track, so it remains for more than two years in each of the twelve star groups along the course.

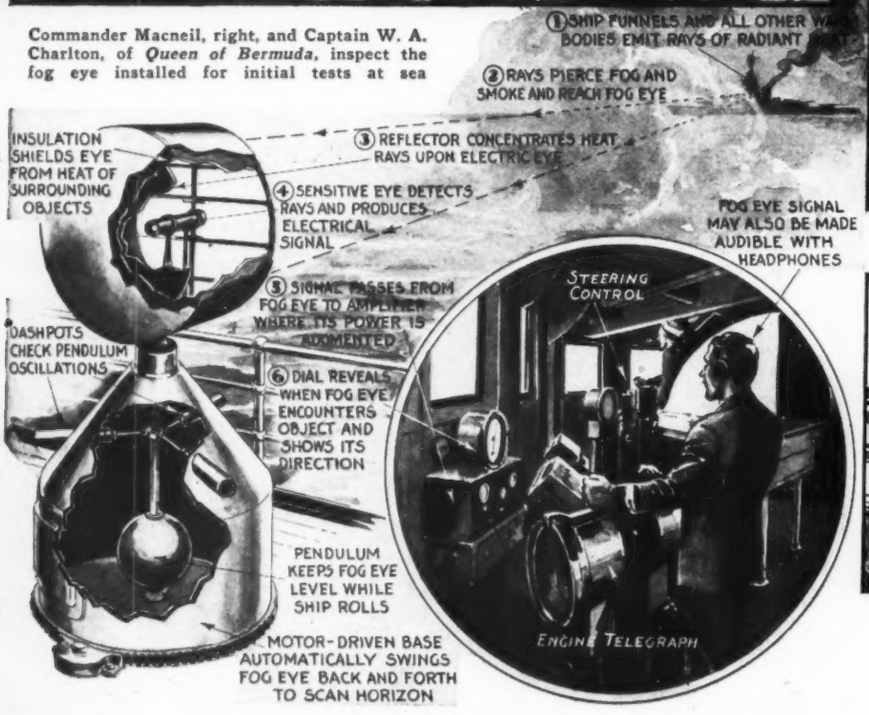
We will first turn our opera glass on Jupiter. You will know where to find him this summer from the dated positions on the blackboard chart. Through a powerful telescope, you would be able to see the variegated belts that cross his disk. These are beyond the power of an ordinary opera glass, though a strong one will reveal one or two of Jupiter's

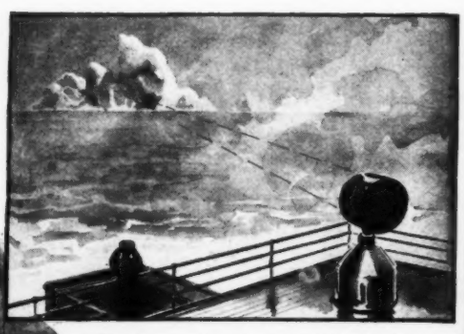
These three maps show the moon from the first quarter to the third and clearly indicate the leading features that are most easily observable at each time of the month

Ship's Magic Eye Pierces Fog

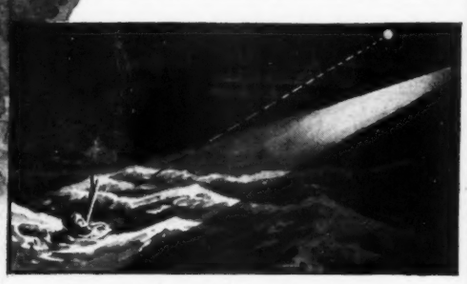
Invisible Rays, Thrown Off by Every Object, are Caught by Photo-Electric Cell and Warning Sounded to Prevent Collision in Fog, Smoke, or Darkness

Commander Macneil, right, and Captain W. A. Charlton, of *Queen of Bermuda*, inspect the fog eye installed for initial tests at sea


1 SHIP FUNNELS AND ALL OTHER WARM BODIES EMIT RAYS OF RADIANT HEAT
2 RAYS PIERCE FOG AND SMOKE AND REACH FOG EYE
INSULATION SHIELDS EYE FROM HEAT OF SURROUNDING OBJECTS
3 REFLECTOR CONCENTRATES HEAT RAYS UPON ELECTRIC EYE
4 SENSITIVE EYE DETECTS RAYS AND PRODUCES ELECTRICAL SIGNAL
FOG EYE SIGNAL MAY ALSO BE MADE AUDIBLE WITH HEADPHONES
5 SIGNAL PASSES FROM FOG EYE TO AMPLIFIER WHERE ITS POWER IS AUGMENTED
DASHPOTS CHECK PENDULUM OSCILLATIONS
6 DIAL REVEALS WHEN FOG EYE ENCOUNTERS OBJECT AND SHOWS ITS DIRECTION
STEERING CONTROL
PENDULUM KEEPS FOG EYE LEVEL WHILE SHIP ROLLS
ENGINE TELEGRAPH
MOTOR-DRIVEN BASE AUTOMATICALLY SWINGS FOG EYE BACK AND FORTH TO SCAN HORIZON



Magic eye detects an invisible iceberg



Eye used in search for drowning man

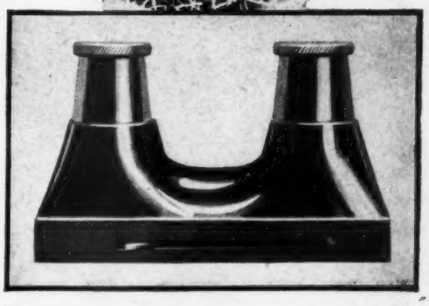
Forest fires are instantly found

SUCCESSFULLY tried out in its first sea tests aboard the liner *Queen of Bermuda*, a new marine instrument called a fog eye reveals the presence of objects hidden by darkness, fog, smoke or artificial smoke screens. Shipping and naval officials see revolutionary possibilities for the remarkable instrument in peace and war. Perils of collision at sea, as a ship plows through darkness or fog, may be removed by the fog eye. On the blackest night, it is said to warn of an approaching vessel as far as fifteen miles away; to detect a menacing iceberg in time to avert a disaster; and even to locate a drowning man, struggling in the water, so that searchlights may be directed on him and rescuers reach him. In time of war, an enemy ship, stealing through the gloom with masked lights, is spotted at once, and the sensitive eye will also warn of approaching airplanes or dirigibles. The secret of the fog eye's power to see in the dark is found in a well-known scientific principle. Every object that is warmer than its surroundings emits rays of radiant heat identical with the rays that stream from the familiar household electric heater. These rays pass easily through fog, smoke, and darkness. Though invisible to the eye, they may be detected by an electric eye, or photo-electric cell, of sufficient sensitivity. It is such an eye that the inventor, Commander Paul H. Macneil, has built into his instrument. Sweeping the horizon, it reacts to any warm body it encounters, and its amplified signal operates an alarm, as explained in the numbered legends of the accompanying drawing. Any object appreciably colder than its surroundings, such as an iceberg, also operates the alarm. Additional uses for the fog eye on land have been proposed, among them, the spotting of forest fires before they have gained sufficient headway to do serious damage. Macneil first plans, however, to offer his invention to the U. S. Navy for use on its vessels as a defensive instrument.

Orchard Sprinkler Gets Unusual Test

To AID in the design of new types of orchard sprinklers, an unusual proving ground has been established by a California engineer. A high shield, equipped with a window, permits an observer to watch the performance of a spray nozzle at close range, without getting drenched. Funnels and test tubes are set in stands at measured distances to study the distribution of the falling spray during a test. If the nearby tubes collect more water than those farther out, or vice versa, the sprayer is considered unsatisfactory. With the aid of the proving range, special types of vibrating spray heads have been devised to give equal distribution of artificial rainfall over the entire area that is being watered.

Funnels, with test tubes attached, are set at measured distances to test distribution of spray by sprinkler. Left, note protecting shield

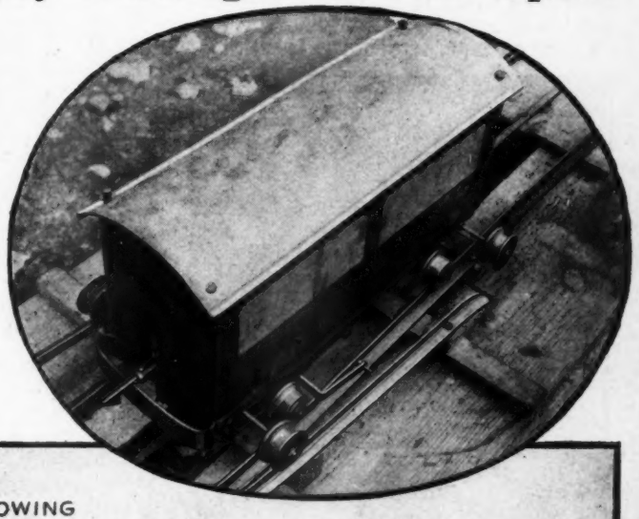


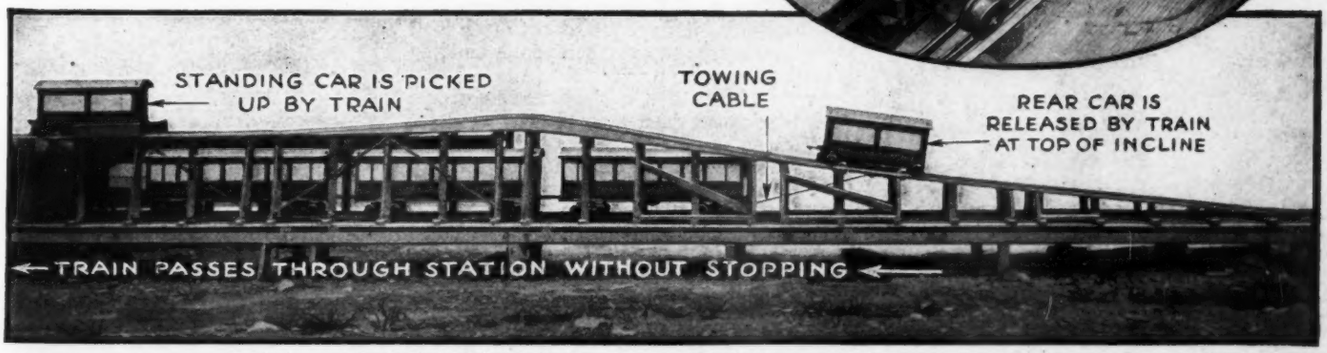
POCKET STEREOSCOPE SHOWS VIEWS ON FILM

GONE is the old-fashioned parlor stereoscope of a generation ago, but its counterpart, in modern guise, has just made its appearance. The new pocket-sized form of the instrument, illustrated above, is as small as a pair of opera glasses and uses thirty-five-millimeter motion picture film instead of paper photographs. A shift lever causes the pictures to appear.

New Pick-Up Transfers Railway Passengers at Full Speed

BOARDING or leaving a speeding express train as it whizzes through a station may be made possible by a pick-up system recently demonstrated with models before French railroad officials. The plan calls for the erection of inclined ramps of wide-gage track at each station. Passengers wishing to leave the train at the next station go to a small trailer car at the rear. This car has an extra set of wide-gage wheels, and is attached to the train by a cable instead of a coupler. When the trailer car strikes the ramp, it ascends the incline, while the cable is paid out from a drum. At the top, an automatic release uncouples the car and transfers the cable to a standing car filled with passengers waiting to board the train. The second car is towed down the opposite end of the incline to the main tracks and joins the train when the cable is reeled in. Shock-absorbing devices minimize the jolt of taking on the sudden load. Passage from the trailer to the main section of the train is made through an ordinary vestibule.

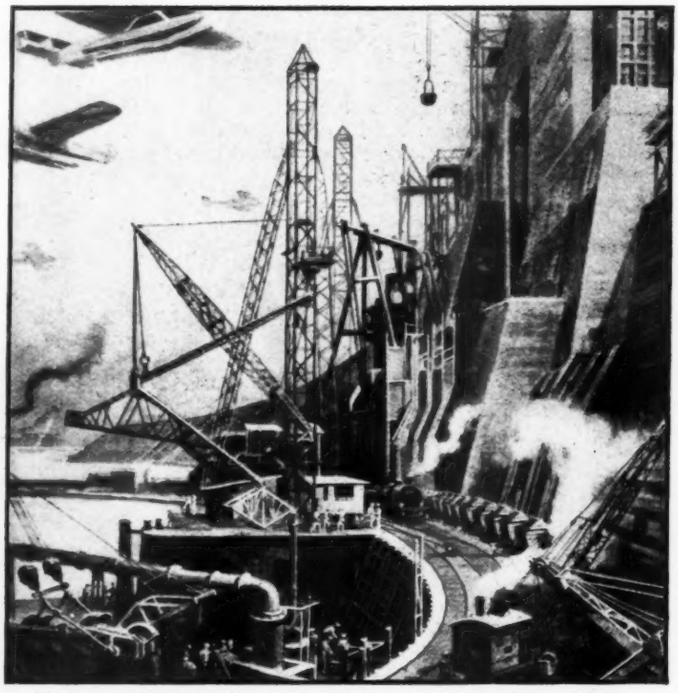



STANDING CAR IS PICKED UP BY TRAIN
TOWING CABLE
REAR CAR IS RELEASED BY TRAIN AT TOP OF INCLINE
TRAIN PASSES THROUGH STATION WITHOUT STOPPING

Dummy passengers were picked up and unloaded without stopping an express train in a recent demonstration with these model cars. Photo shows model train about to uncouple its trailer car and take on one standing on ramp. In oval, close-up shows how trailer engages ramp with extra wheels

Big Dam to Water Sahara

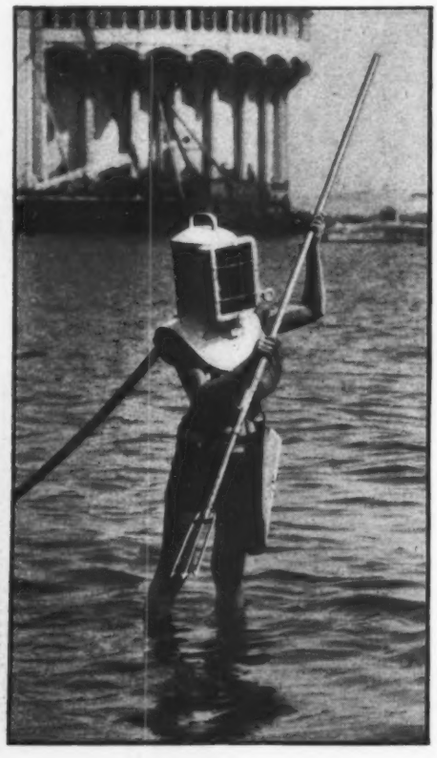
TURNING the Sahara Desert into blossoming farm land, with water drained from the Mediterranean Sea, is the ambitious project for which Hermann Sorgel, German engineer, seeks international support. He proposes to dam the Strait of Gibraltar, and then cut a canal to flood portions of the Sahara below sea level. Evaporation from the inland lake thus formed would produce rain clouds and water a vast area, he maintains. By-products of the scheme would be hydroelectric power and new land reclaimed from the Mediterranean.



Above, artist's conception of the dam proposed for the Strait of Gibraltar and intended to help flood low parts of the Sahara Desert. At left, Herman Sorgel, originator of scheme, with model of Mediterranean

CALIFORNIA FISHERMEN WEAR DIVING HELMET

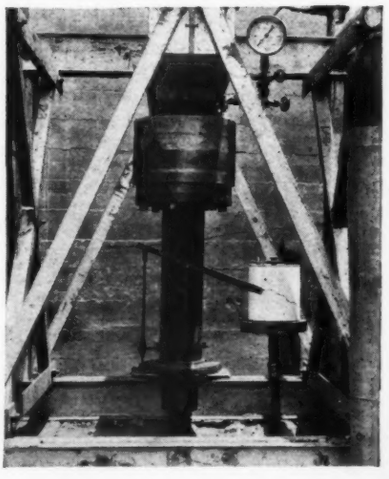
FISHING in a diving suit is the latest sport innovation at Catalina Island, Calif. Equipped with a diving helmet, and weighted down with a lead belt and shoes of the same heavy metal, the submarine fisherman walks out from shore as shown below. His trailing air hose is attached to a compressor on shore, behind him. He carries a long-handled, three-pronged spear with which to kill his catch—if he can. As fish usually are attracted by the escaping air bubbles, the sport is exciting.



WEIGHTS TEST NEW BUILDING SITE

SETTLING foundations, that cause unsightly cracks in the walls and ceiling of a building, are forestalled by an unusual testing device. Invented by R. V. LaBarre, an engineer, Los Angeles, Calif., it determines how much load a plot can safely support before the building is erected.

At the chosen site, a steel column with a wide base is set in a hole thirty feet deep. To the top of this beam is then added the weight of two wooden boxes filled with fifty tons of earth (illustrated in oval above). The settling of the soil under the heavy load is indicated by a pen moving across a revolving chart, as shown in the photograph at right. From this chart, the fitness of the site is passed upon. An ingenious form of jack, consisting of a cylinder filled with compressed nitrogen gas, transfers the weight of the boxes of earth to and from the column.



New Rotor Ship Sails in Lightest Wind

Laurence J. Lesh, aeronautical engineer, displays a working model of his rotor ship which will be exhibited at Chicago Fair

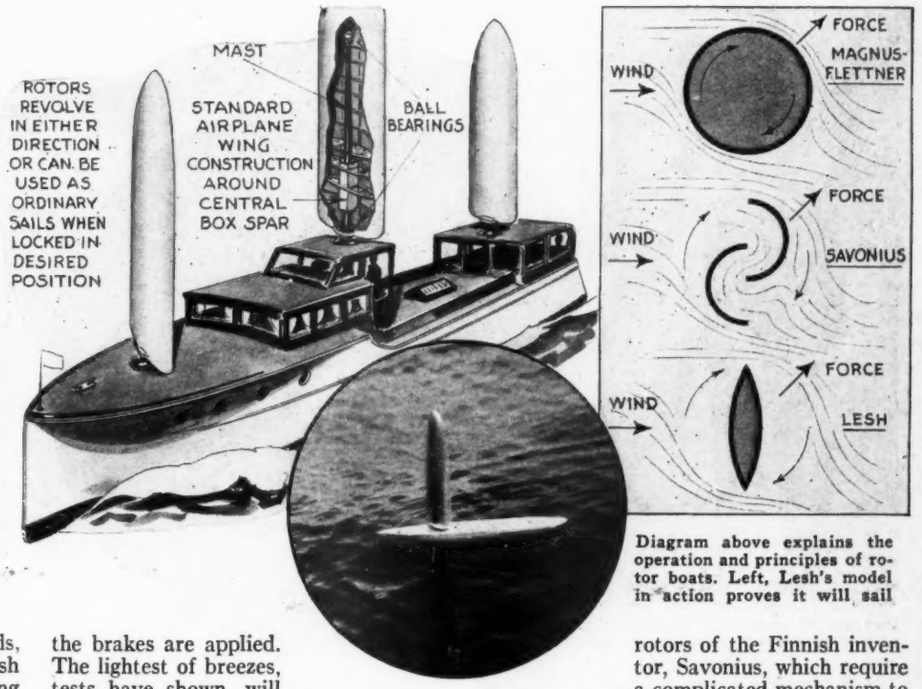


Diagram above explains the operation and principles of rotor boats. Left, Lesh's model in action proves it will sail

LOOKING like whirling surfboards, strange new rotors will furnish the power on a boat now nearing completion at Chicago. Laurence J. Lesh, pioneer aeronautical engineer, is designer of the craft.

Unlike the Flettner rotor ship, which attracted wide attention a few years ago, his boat will depend entirely upon the wind for propulsion. No engines will be required to keep the rotors turning, as was the case with the high "chimneys" of the German craft. Once the pointed, vertical wings of the Lesh boat begin spinning, they keep on until the wind dies down or the brakes are applied. The lightest of breezes, tests have shown, will start them whirling and move the ship.

For more than a year, Lesh has been experimenting with miniature rotor ships in the model boat basin in Jackson Park, besides conducting various wind-tunnel tests. His researches have shown that the spinning wings of his models will pull the boats directly into the teeth of the wind and that they will give almost four times the propelling power of ordinary sails. They spin equally well in either direction, an improvement on the S-shaped rotors of the Finnish inventor, Savonius, which require a complicated mechanism to shift the halves of the rotor when a ship heads about and takes a new course in the opposite direction.

The full-sized experimental boat, nearing completion, will be used to try out rotors of various sizes and constructions. Different rotors of the same size will be covered with canvas, plywood, and polished duralumin and tested to discover which material is best suited for the work. To drive a seventy-foot cabin cruiser, Lesh says, three rotors would be needed.

RACK HELPS IN PAPERING CEILING

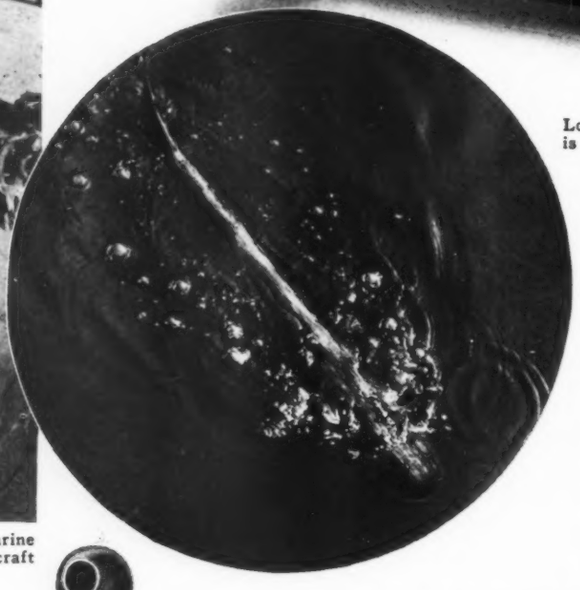
PAPERING ceilings can now be done easily by the layman, it is claimed, with the aid of a hanger recently introduced. It consists of an adjustable rack that aligns and holds the paper, gives or takes up the slack as needed, and leaves the operator's hands free. The hanger can be adjusted for height and for the width and weight of paper. As shown in photo above, the rack can be used on a narrow scaffold.

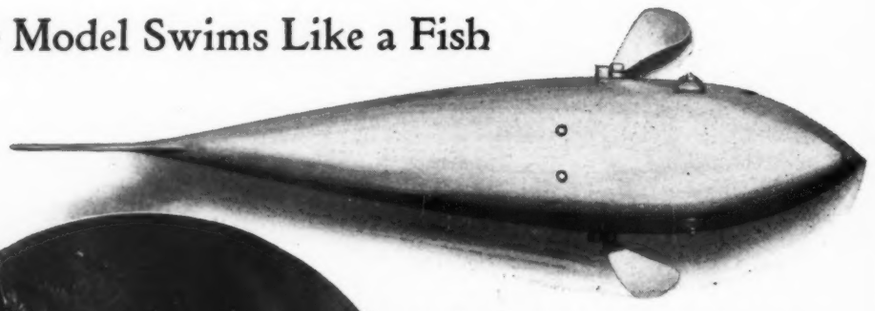
FIVE-BLADED RAZOR CUTS SHAVING TIME

FIVE blades, instead of one, are used in a new type of safety razor introduced by a French inventor. One stroke of the razor across the face is said to remove every trace of hair in its path. The speed of the resulting shave is enhanced by the fact that the razor need not be taken apart after shaving. It is merely rinsed under the faucet and screwed, head down, in its special case. The blades require no sharpening, according to the maker, and will give good service indefinitely.

New Submarine Model Swims Like a Fish

Inventor of propellerless submarine with a model of his unusual craft





Looking like a fish, this model of a submarine is propelled by fins. At left, model in the water

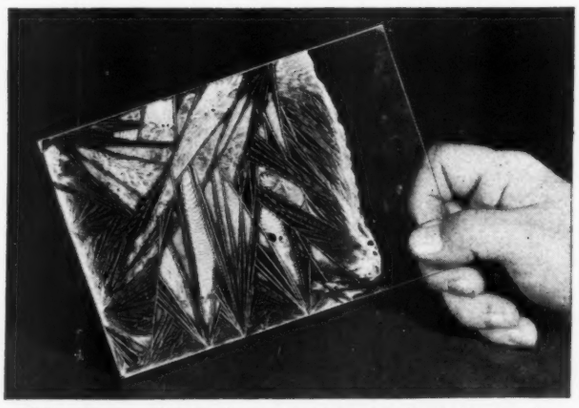
OBSERVING the motions of swimming fish, Franz Heudorf, German inventor, resolved to test their method of locomotion as a means of propelling water craft. Recently he demonstrated, with working models, a new fin drive, dispensing entirely with propellers, which the inventor maintains is especially adaptable to submarines. Small rotating fins on each side of the vessel are operated independently of one another, and may be set to cause the craft to go forward or astern, turn to port or starboard, and dive or come to the surface without pumping ballast. Plans are reported under way for the construction of a man-carrying submarine using the new system of fins as propellers.

TIRE VALVE TESTER FITS VEST POCKET

LEAKS in tire valves are quickly detected with the aid of a new pocket tester, illustrated at right. The flexible rubber socket fits over a valve stem, making an air-tight seal. If any air is escaping from the valve, bubbles appear at once in a glass cylinder containing water. The device eliminates the uncertainty of the familiar wet-finger test. It is provided with a holding clip and can be carried conveniently in the vest pocket, exactly like a pencil, and is thus always instantly at hand when an annoying slow leak, sometimes hard to find, makes it necessary to use it.

PAINT FORMS DESIGNS WHILE DRYING

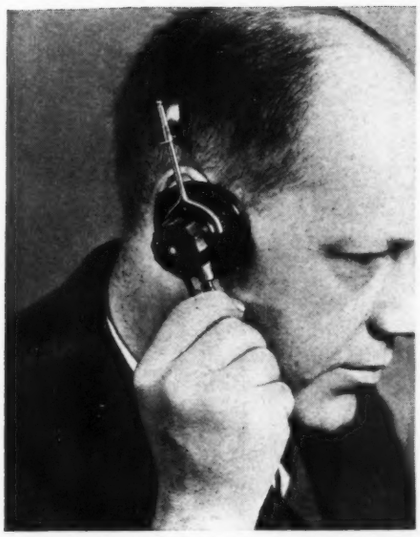
A NEW paint, that forms its own designs, is easily applied by an inexperienced person to lamp shades, vases, electric push-button plates, and other household objects. Decorative lines and patterns appear as if by magic during the drying, by a process similar to crystallization of certain salts from an evaporated solution. Six different colors, besides black and white, are available. The paint may be applied to metal, glass, or cellophane.



This paint, applied to glass or earthenware, forms its own design while it is drying. No experience is needed to use it

NEW BOWLING ALLEY HAS NO PIN BOYS

ELECTRICITY does all the work of pin boys in a new type of bowling alley that eliminates delays in play. Duck pins are used, suspended on chains and held in place by steel seats with triggers. When a ball knocks a pin off its base, it is automatically lifted out of the way. The balls are returned automatically by an iron rocker-arm that picks them up and deposits them in the inclined side gutter. Then, merely by pressing a foot lever, the player sets all the pins up again. Power for the all-electric alley is supplied by a one-half horsepower motor. The photograph shows one of the new alleys in use with the mechanical pin boys removing and setting up the pins.

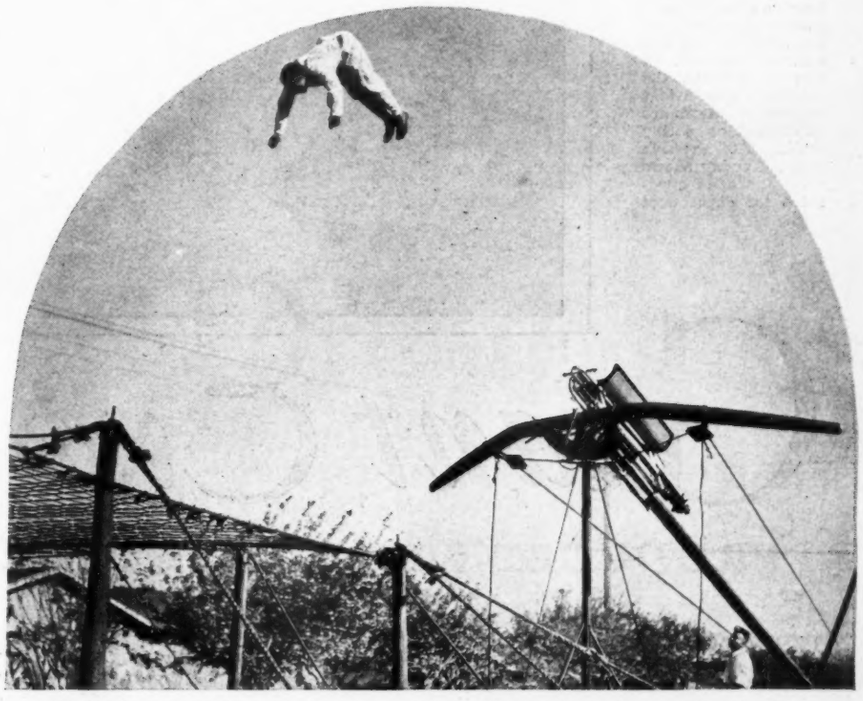


COMPLETE RADIO SET PUT IN HEADPHONES

INVENTIVE ingenuity has succeeded recently in building a complete radio set into a pair of headphones. No batteries are required, since the set uses a crystal detector, which is adjusted by manipulating a small knob on one of the receivers, as shown above. To tune in any station, the user has merely to turn a larger knob at the back of the same receiver, operating a diminutive tuning condenser. The set will operate successfully wherever the cords of the set may be plugged into a convenient aerial and necessary ground connections are possible.

BIG CROSSBOW HURLS MAN FIFTY FEET

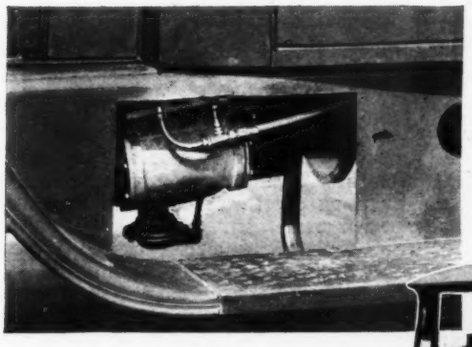
SOMERSAULTING fifty feet through the air from a giant crossbow, a California daredevil recently introduced a new circus thrill. Billed as a human arrow, he takes his place in a small metal cradle and braces himself for the shock of starting. At a given signal, an assistant trips a trigger and the acrobat is hurled into the air and lands in a net fifty feet away. The cradle is driven by a coil-spring mechanism said to exert a driving force of more than 20,000 pounds.



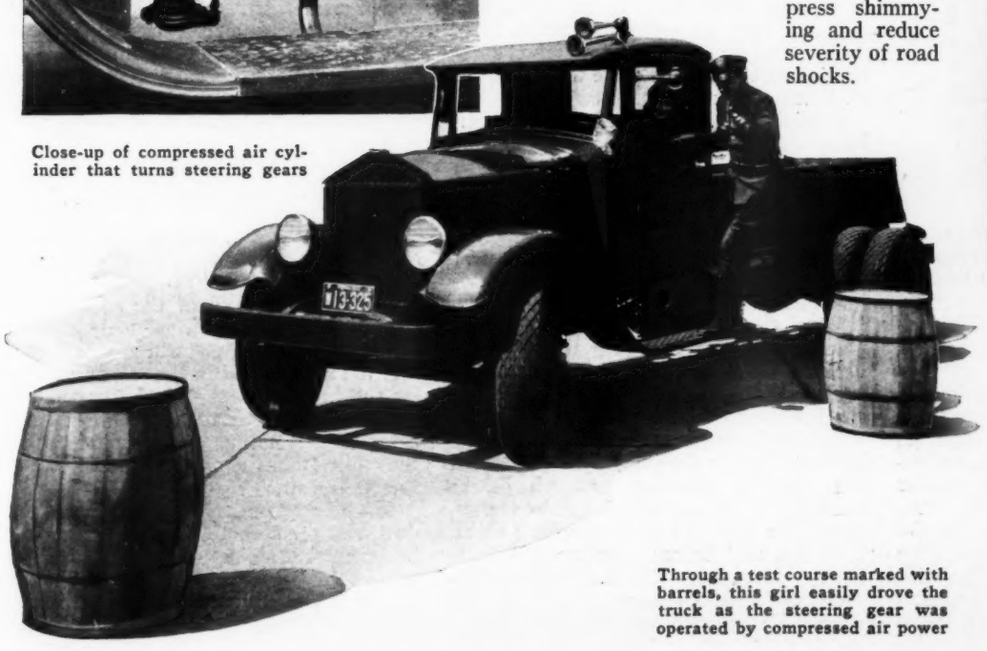
Hurled by a powerful spring from the cradle of this crossbow, the man flies fifty feet

COMPRESSED AIR NOW STEERS AUTO

COMPRESSED air replaces muscle power in a new steering system for automobiles. Even a heavy truck, equipped with the air-power installation, is steered by a finger's touch. Turning the steering wheel, automatically admits compressed air to a double-acting piston that moves the front wheels of the vehicle. The new system is said also to supress shimmying and reduce severity of road shocks.



Close-up of compressed air cylinder that turns steering gears



Through a test course marked with barrels, this girl easily drove the truck as the steering gear was operated by compressed air power

ALUMINUM FOIL SUPPORTS SWING

TO DEMONSTRATE the strength of aluminum foil, engineers recently arranged the unusual test pictured above. Three of the thin metal sheets, each about six ten-thousandths of an inch thick, formed a support for a swing in which a young woman sat. The improvised swing, calculations showed, could support 200 pounds.

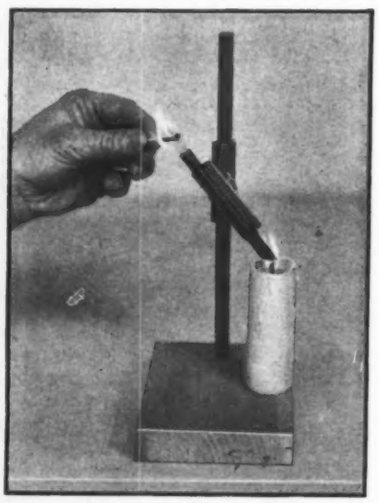
GRAIN DUST EXPLOSIONS

Inside the can, right, is a lighted candle. Through the tube, cornstarch is blown into the candle's flame which explodes it so the cover of the can will be blown off. In this experiment, the destructive explosions in grain elevators are duplicated on a tiny scale. At extreme right, drawing shows arrangement of apparatus for experiment

Giant Explosions

REPRODUCED IN MINIATURE

by Home Chemists



To prove that every burning candle is a gas plant, incline a tube over the flame, as is shown above. In a short time, gas, escaping from the tube, can be lighted

HARMLESS, miniature explosions make experimenting with combustibles a thrilling, yet safe, amusement for the amateur chemist. With inexpensive homemade apparatus, he can duplicate the explosions in a gasoline motor and amuse his friends by burning air.

When we say a substance burns, we imply that it combines with oxygen to produce heat and sometimes light. Hydrogen and carbon, as well as many other substances containing these two elements, display this property. A candle, for instance, is made of paraffin, a combination of carbon and hydrogen. When the wick is lighted, the paraffin melts and produces hydro-carbon gases, which decompose to form other inflammable gases and carbon.

If a cold object is held in a candle's yellow flame, a black coating will be deposited on its surface, proving that free carbon is given off. That burnable gases are present can be shown by inserting the end of a short metal or glass tube in the flame and igniting the unburned gases issuing from its outer end.

In the case of the candle, the hydro-carbon gases unite slowly with the oxygen of the air. If by some means this action is speeded up, an explosion results. It is this speeded-up type of hydro-carbon combustion that is used to drive the pistons in an automobile motor.

A miniature explosion of this type can be carried out safely in the home laboratory by making use of the hydro-carbon vapors given off by a few drops of gasoline. First select a suitable tin can having a friction top that does not fit too tightly. Make a half-inch hole in one side near the top, place two or three drops of gasoline in the can, and fit the friction top.

With the can supported on a stand, place a lighted candle near the hole and heat the bottom or side of the can with a gas or alcohol flame. As the can is heated the inflammable liquid will vaporize, mix with the inclosed air, and leak out the half-inch hole in the side of the can. When the mixture contains just the right amounts of air and hydro-carbon vapors, it will be ignited by the candle and an explosion will follow. The cover will be gently blown from the can or the receptacle will kick sideways away from the candle. Being small and in an unconfined vessel, the explosion will be quite harmless if directions are carefully followed.

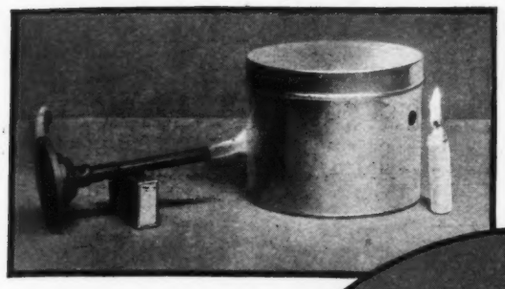
In fact, any of the miniature explosion experiments to be described can safely be performed in the living room, provided you use reasonable care.

News items telling of violent explosions that blow up grain elevators always strike a note of mystery. Grain and explosions somehow do not seem related. However, by using cornstarch, the amateur chemist can create such an explosion and study the strange phenomena caused by the instantaneous burning of grain dust.

To do this, punch a small hole in the bottom of a half-gallon tin can. A funnel containing a teaspoonful of cornstarch is then placed in the hole from the inside so its stem extends below the can. Connect a short length of rubber tube to the outer end of the funnel, place a lighted candle in the can, and fit the friction cover in place. As before, the cover should not be a tight fit.

Place the free end of the rubber tube in your mouth and blow suddenly into the hose. The cornstarch will be scattered into the air inclosed in the can and, aided by the heat from the candle flame, will unite rapidly with the oxygen. In most cases, the resulting explosion will blow the cover from the can and raise it a half foot in the air.

Flour, charcoal, lycopodium, fine coal dust, and other common combustibles can be made to ignite and explode in the same way. Better results often can be obtained if the substance is first heated to remove any moisture that may be present.



How Blasts of Grain Dust or of Gasoline Vapor Are Caused in Your Laboratory—Tests With Which to Prove a Burning Candle Is a Gas Plant

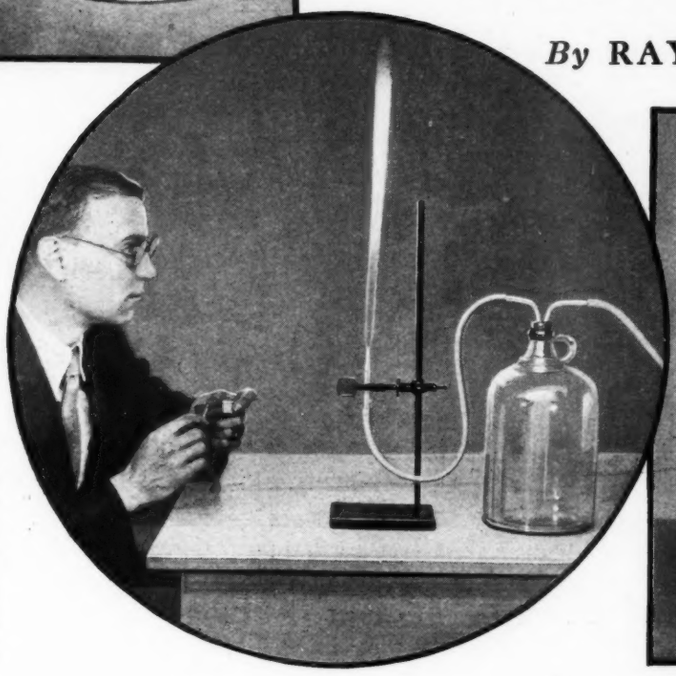
By **RAYMOND B. WAILES**

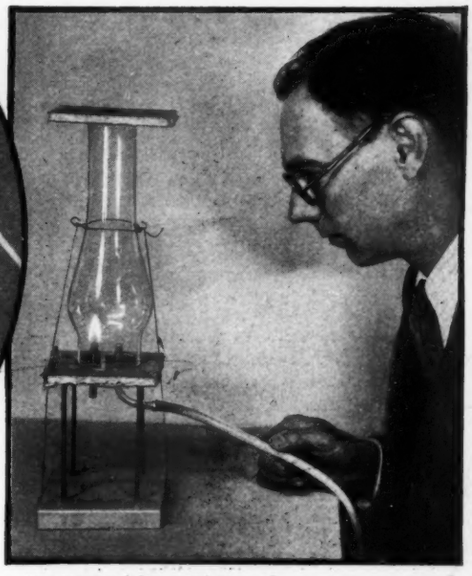
EXPLODING GASOLINE

Two or three drops of gasoline are placed in the can, above, and the can is then heated with a Bunsen burner. Opposite an opening in the can, place a lighted candle. As the gasoline is vaporized by the heat, it will be ignited by the candle and blow off the cover

FLAME THAT CAN HEAR

In the experiment, right, gas flows into the bottle and then escapes through the left-hand tube which is fitted with a medicine dropper. The gas is lighted and burns up in a steady flame. Any noise, as the scratching of a match, will make the flame duck as though it were avoiding a blow





MAKING AIR BURN. **Arrange your apparatus as above with lamp chimney fastened securely in place. When gas is lighted at the bottom of the open tube, it will burn there for a time and then retreat up tube and burn air inside the chimney**

Although these experiments tend to show that all substances containing carbon or hydrogen are inflammable or explosive, this is not the case. Carbon tetrachloride, for instance, is a combination of carbon and chlorine used for extinguishing fires and, as a cleaning fluid that will not burn, it is used in place of gasoline and benzine. Instead of exploding or burning, carbon tetrachloride decomposes when held near a flame.

To illustrate this, moisten a small wad of cotton with the liquid and hold it around the base of an oil lamp or lantern. The vapors will be decomposed and the carbon liberated will condense on the glass globe as a black coating.

If the moistened cotton is held at the air ports in the base of a Bunsen burner and a copper wire is held in the normally blue flame, the flame will change to a bluish-green. This color change is caused by the chlorine given off when the carbon tetrachloride decomposes. The chlorine unites with the copper and then breaks down again to form copper vapor and chlorine gas. If a cold, white surface, such as the bowl of a bubble pipe, is held in the bluish-green flame, a visible coating of the copper will be deposited on it.

One would hardly expect to burn air. Yet, with a simple arrangement of parts consisting of a lamp chimney, some plaster board, a few pieces of glass tubing, and several feet of rubber hose, the home chemist can do just this.

Support the glass lamp chimney on a sheet of plaster board fitted with two glass or metal tubes, one fourth inch in diameter. The tubes, about three inches long, should extend up into the chimney about half their length. When the chimney has been wired or otherwise fixed in position to prevent it from toppling over, place over the chimney top a sheet of plaster board having a half-inch hole in its center as is shown.

Place a finger over the hole in the plaster board capping the chimney and turn on the gas. After a half minute, light the gas issuing from the free tube under the chimney, turn the gas low, and remove your finger from the upper hole.

At first, the gas will burn outside the lower tube. When the finger is removed, however, the flame will travel up the inside of the tube and appear at the end of the tube inside the chimney. With the bottom end of this tube open to the air, the flame in reality is caused by the air burning in an atmosphere of gas. This type of action is called a "reciprocal combustion." Since combustion is the combination of a flammable substance with oxygen, either will burn in an atmosphere of the other.

This same arrangement of parts can be used to show, in a rather unique way, that gas becomes explosive only when mixed with oxygen. After completely ventilating the chimney to remove all the gas, place a finger over the outer end of the free air tube and allow only pure gas to enter the chimney. After about a half minute, light the gas issuing from the hole in the plaster board chimney cover. Then shut off the gas and remove your finger from the bottom tube.

The gas in the chimney will rise and continue to burn at the hole in the plaster board. Since air also will enter the chimney through the opened bottom hole, the chimney soon contains a mixture of gas and air. When this mixture is composed of just the right proportions of each, the flame burning outside will suddenly dart into the chimney and cause the air-gas mixture to explode with a harmless swish.

In most cases, the explosion will not be violent enough to blow the loose plaster board cap from the chimney. However, as a precaution, do not under any condition fasten the plaster board firmly in place.

A novel magic flame, more sensitive to sounds than our own ears, forms one of the most amusing experiments the home chemist can perform.

A gallon or half-gallon bottle serves nicely for this experiment. Fit it with a cork supplied with two short glass tubes and connect the gas supply to one and a rubber hose fitted with the glass portion of a medicine dropper to the other. After waiting for the air to be driven out of the system light the gas at the tip of the medicine dropper. With the gas turned on full, the flame will roar.

Then place a suitable pinch clamp over the rubber tube leading to the inlet of the bottle and throttle the gas gradually until the flame burns less violently and ceases to roar. In this condition the flame will be sensitive to the faintest vibrations.

Every noise will cause the flame to duck. Even the slight scratching noise made when striking a match will cause the sensitive flame to dart. By experimenting you will find that high-pitched sounds cause the flame to shorten or dodge more than low notes. A flame of this type is so sensitive that it responds to vibrations so rapid (high-pitched) that they cannot be heard by the human ear.

NEW ELECTRICAL SYSTEM GIVES VAST TONE TO

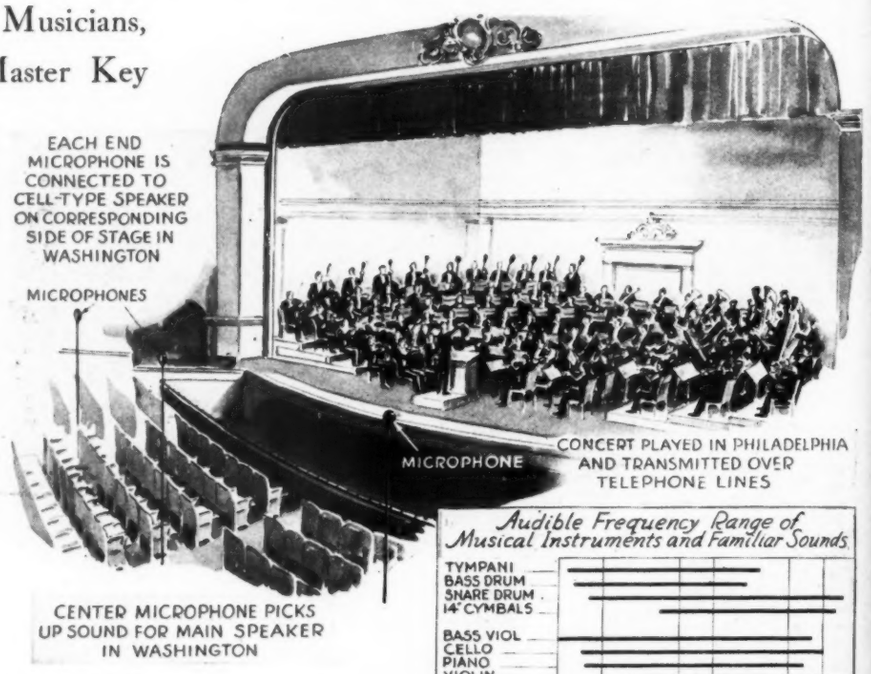
Full Orchestra *on* Empty Stage

Conductor, 150 Miles from Musicians, Controls Expression with Master Key

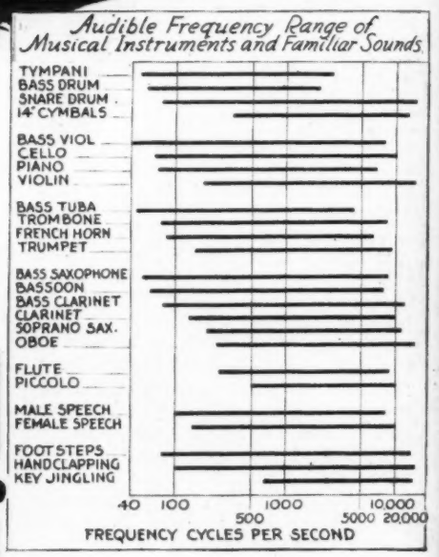
ORCHESTRAL music such as never before had been publicly heard, poured from the apparently empty stage of Constitution Hall, Washington, D. C., a few nights ago when Dr. Leopold Stokowski, conductor of the Philadelphia Symphony Orchestra, demonstrated before the National Academy of Sciences, a new electrical system of musical reproduction and transmission developed by engineers of the Bell Telephone Laboratories.

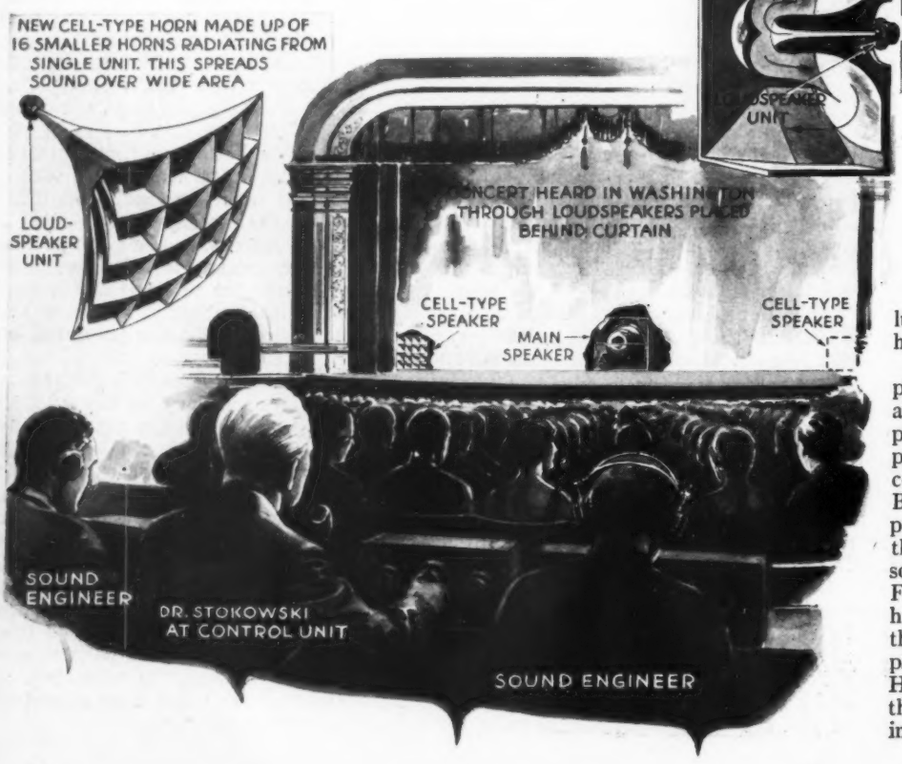
The source of the music was the stage of the Academy of Music in Philadelphia, 150 miles away. There the hundred musicians of the Philadelphia Symphony Orchestra played a program of standard orchestral numbers. In front of the Philadelphia stage stood three sensitive microphones, one in the center and one at each side. Each was connected separately by telephone lines with a loudspeaker that stood behind a sound-porous curtain on the stage in Washington.

In the rear of Constitution Hall sat Dr. Stokowski, before him a small oblong box, not unlike a midget radio receiver, with a front panel equipped with three dials and a pair of switches. Manipulating these devices, the conductor controlled the music of the far-away orchestra, hushing the sounds issuing from the loudspeakers until they were barely audible, and then making them swell to twenty times the volume produced by the actual orchestra.


EACH END MICROPHONE IS CONNECTED TO CELL-TYPE SPEAKER ON CORRESPONDING SIDE OF STAGE IN WASHINGTON
MICROPHONES
MICROPHONE
CONCERT PLAYED IN PHILADELPHIA AND TRANSMITTED OVER TELEPHONE LINES
CENTER MICROPHONE PICKS UP SOUND FOR MAIN SPEAKER IN WASHINGTON

Drawing, above, shows source of the music as orchestra plays before three microphones which carry the tones to loudspeakers 150 miles away. Below, loudspeakers with the control unit that permits conductor to regulate their output

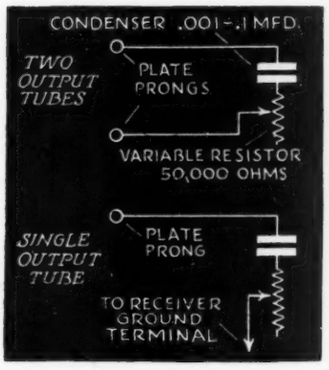



NEW CELL-TYPE HORN MADE UP OF 16 SMALLER HORNS RADIATING FROM SINGLE UNIT. THIS SPREADS SOUND OVER WIDE AREA
REFLECTING TYPE OF EXPONENTIAL HORN USED IN MAIN SPEAKER. ARROWS SHOW PATH OF SOUND
LOUD-SPEAKER UNIT
CONCERT HEARD IN WASHINGTON THROUGH LOUDSPEAKERS PLACED BEHIND CURTAIN
CELL-TYPE SPEAKER
MAIN SPEAKER
CELL-TYPE SPEAKER
SOUND ENGINEER
DR. STOKOWSKI AT CONTROL UNIT
SOUND ENGINEER

At no time was there any suggestion of distortion, nor any hint, in the quality of the music, of the electrical transfer it had undergone. For the new apparatus—microphones, amplifiers, electrical filters, transmission lines, and loudspeakers—reproduces with absolute fidelity all sounds that the normal human ear is capable of hearing.

Moreover, the location of the microphones in reference to the source of sound and the placing of each loudspeaker in a position that corresponds with that of the particular microphone with which it is connected brings about an effect that the Bell Telephone engineers call "auditory perspective," that is, an illusion that causes the listener to seem to hear a specific sound from the point at which it originates. For example, the audience in Washington had no difficulty in telling just where on the Philadelphia stage the brasses, tympani, bass viols, and so on were placed. Hum and the other noises are only one three-hundredth of those heard from moving-picture theater sound equipment.

HOW YOU CAN PUT Tone Control *on your* RADIO RECEIVER



Simple connections to receiver output tubes make it easy to add a tone control to your radio set if it is not already equipped with one. Left, diagram of wiring necessary

IF YOUR broadcast receiver is not equipped with a tone control, you can provide one for less than a dollar. By following the simple connections indicated, any one can hook up this efficient tone control without altering one connection in the receiver.

The auxiliary tone control consists principally of a fixed condenser connected in series with a suitable variable resistor and placed across the output of the receiver. If the receiver has two output tubes in push-pull arrangement, the series-connected condenser and resistor can be connected across the plate prongs of the output tubes. If the receiver circuit terminates in a single output tube, one end of the auxiliary circuit is connected to the plate prong of the single tube and the other end is connected to the ground binding post of the receiver.

Connections to the plate of an output tube can be made by removing the tube from its socket, locating the plate prong by its position (P.S.M., Apr. '33, p. 62), and looping the bared end of a piece of insulated wire around the prong close to the base. In replacing the tube be sure that it is pressed tightly into place and bring the insulated wire out from between the tube and socket by the shortest route. If desired, special wafer adapters can be obtained from any large radio dealer for making these connections.

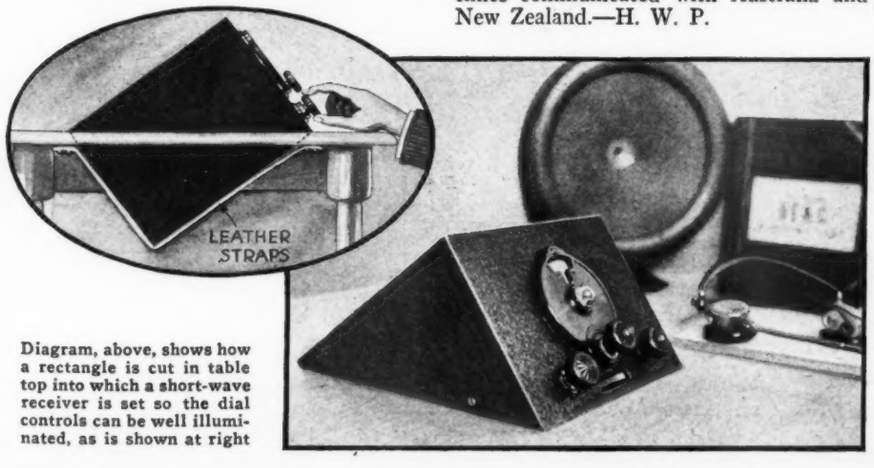
In the diagram, the variable resistor is valued at 50,000 ohms and the capacity of the condenser from .001 to .1 mfd. Since the best value for the condenser will depend on the types of tubes used in the receiver, a range of values has been given. First try the smaller, then the larger, and finally a few intermediate values. Retain the one that gives the best results over the full range of the resistor.

When all the resistance is placed in the circuit, the tone control will have virtually no effect on reception. As the resistance is reduced, however, more and more of the high frequencies will be sent through the condenser instead of the loudspeaker.

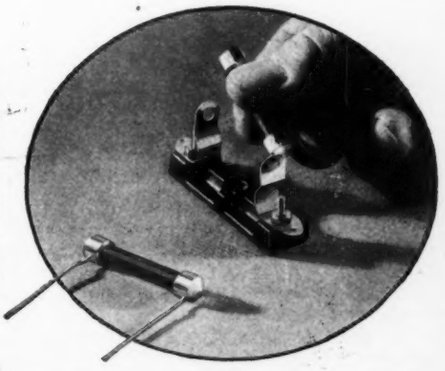
Depending on the room available, the variable resistor can be mounted separately or on the receiver panel.

Receiver Sunk in Table Top

AMATEUR radio operators who spend long hours on the air can obtain better tuning and greater comfort by countersinking their short-wave receivers below the surface of the table. As shown in the illustrations below, a rectangular hole is cut in the table top and the receiver cabinet is set in so the front panel rests at an angle. Wooden braces or leather straps are screwed to the underside of the table top to form a cradle for the receiver. The rectangle should be as long as the cabinet and slightly narrower than the diagonal of the cabinet end. Besides giving greater freedom in dialing, this angular position of the controls allows better illumination of the dial faces. This system of mounting short-wave apparatus is used by a group of St. Louis, Mo., amateurs who have many times communicated with Australia and New Zealand.—H. W. P.



Diagram, above, shows how a rectangle is cut in table top into which a short-wave receiver is set so the dial controls can be well illuminated, as is shown at right



Two of the new miniature lightning arresters

Tiny Lightning Arrester

A NEW type of lightning arrester is now available to the set builder and radio fan. It is no larger than an ordinary grid leak and can be attached by means of its pigtails directly to the ground and antenna terminals at the rear of the receiver or mounted in a spring clip as shown above. It is also suited for use as a protection on the antenna impedance matching transformer in shielded transmission line antenna systems. One end connects where the transformer attaches to antenna wire, the other to grounded shielding.

Using the New Tubes

Adapters Make It Possible to Modernize Old Receivers Without Changing Sockets

Using a simple adapter, the old-style '80 rectifier is being replaced, above, with the new full-wave, mercury-vapor tube type '82. Many other substitutions of this nature are made possible by new, economical adapters

By **GEORGE H. WALTZ, Jr.**

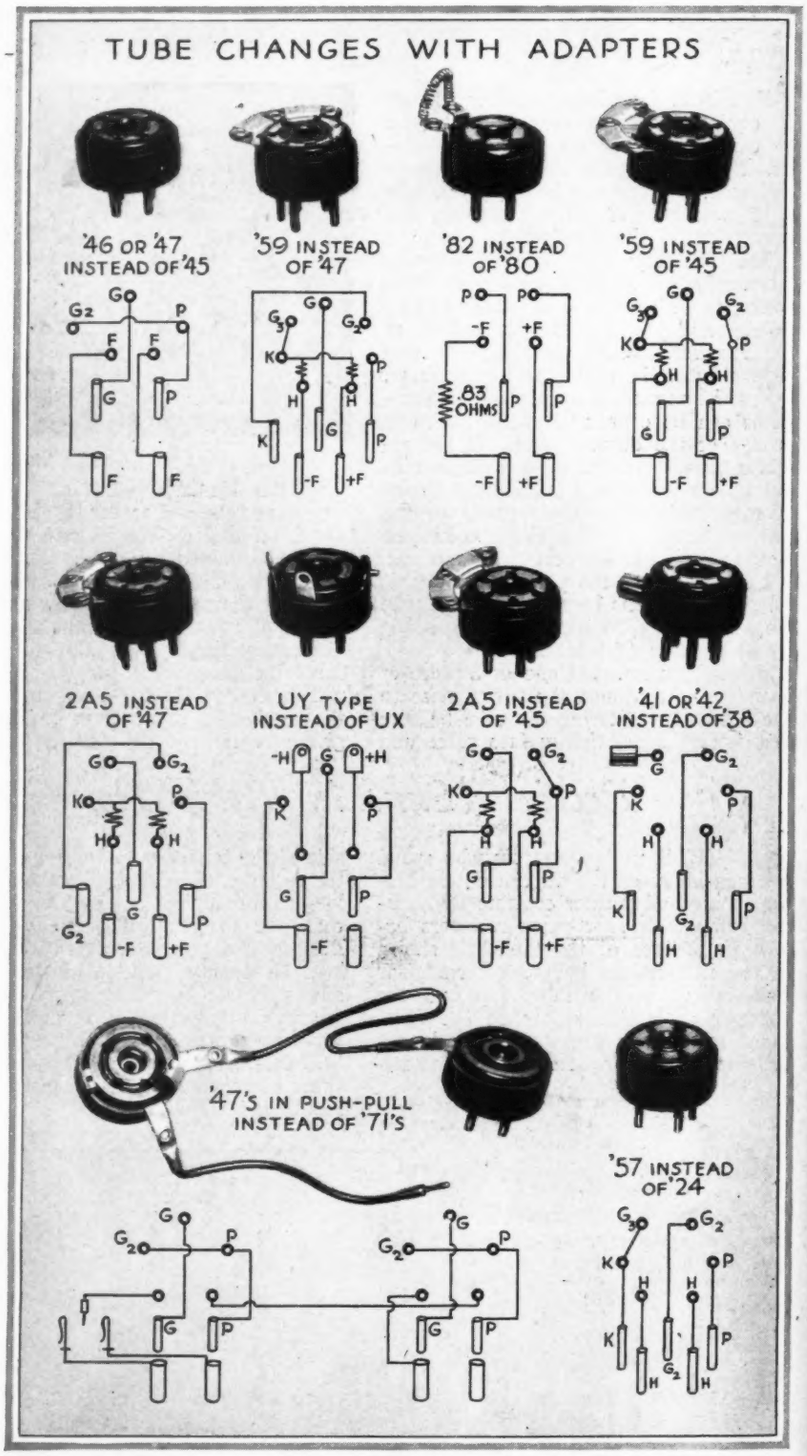
SPECIAL adapters now make it possible to use the new tubes in old radio receivers. Without changing a socket or touching a connection, you can modernize your set by installing tubes of the latest design.

Hitherto, with each new tube development, set owners have been discouraged by the fact that the improved types could not be used to replace their old tubes. Physical differences in the construction of the tube base and in the general design made direct substitution of the new for the old impossible.

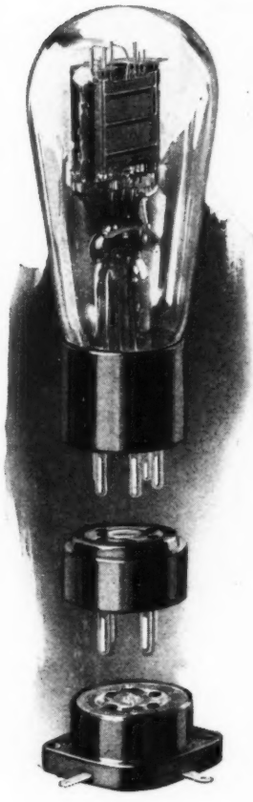
By using the adapters shown on this page direct substitution is now practicable. In fact all sorts of tube replacements are made feasible. For instance, small-based UX tubes can be fitted into old bayonet type, WD-11, or UV-199 sockets. Heater tubes of the '56 or '27 type can be used in sockets designed for filament tubes of the '01A and '26 variety. Five-prong tubes can be inserted in four-prong sockets and tubes requiring a 2½-volt filament supply can be plugged into sockets wired for 5 volts. Thus old style receivers can now be modernized with new tubes at little cost.

Of greatest interest are the simple adapters that make possible the use of the newer type output tubes in sets designed for the older '71A and '45 tubes. For example, one adapter having a five-prong socket and a four-prong base makes the proper internal connections so a type '47 tube can be placed in a '45 socket to obtain greater volume. The '47 is inserted in the adapter and the adapter in turn is placed in the original '45 socket. No other changes are necessary. The adapter connects the '47 into the circuit as a high-mu triode, resulting in increased amplification. This same adapter can be used to substitute a type '46 for a '45 or a type '33 in a '30 or '31 socket.

Using a slightly different adapter, the brand-new 2A5 power amplifier can be substituted for the '45. The adapter, consisting of a six-prong socket and a four-prong base, has a special


TUBE CHANGES WITH ADAPTERS
'46 OR '47 INSTEAD OF '45
'59 INSTEAD OF '47
'82 INSTEAD OF '80
'59 INSTEAD OF '45
83 OHMS
2A5 INSTEAD OF '47
UY TYPE INSTEAD OF UX
2A5 INSTEAD OF '45
'41 OR '42 INSTEAD OF '38
'47'S IN PUSH-PULL INSTEAD OF '71'S
'57 INSTEAD OF '24

With these adapters, old sets can now be modernized. The drawings under each photo show the connections automatically made by the adapters to allow newer-type tubes to be used in the old receivers



in Your Old Set

built-in, center-tapped filament resistor to eliminate hum. If your present receiver terminates with a '47, you can substitute the new 2A5 tube for it by using an adapter having a six-prong socket and a five-prong base.

Other adapters make it possible to obtain greater volume with decreased hum by substituting a seven-prong '59 pentode for either a four-prong '45 or a five-prong '47. Both adapters contain internal, center-tapped filament resistors.

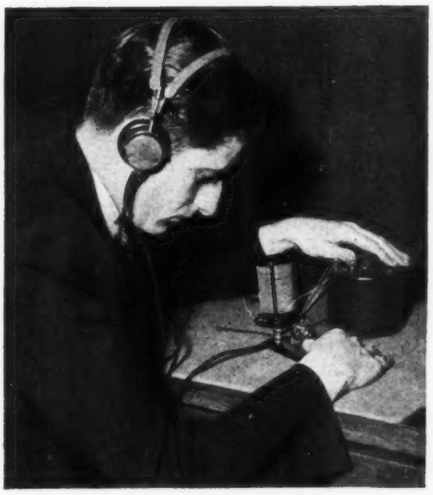
Sets using two '71's in push-pull arrangement can be improved by making use of a special dual adapter that allows the use of the newer type '47 pentodes in '71 sockets. No change, other than the insertion of the adapters, is necessary. The two pentodes automatically are wired in series so that no series resistor is required. One adjustment, however, is necessary. Since many sets, using '71's, have the filament circuit crossed, one of the adapters is equipped with a phone-tipped lead and two spring-clip terminals. The lead must be inserted in the terminal that lights up the tubes when they are placed in the circuit. How this set of adapters is wired is shown in the diagrams.

In many receivers, a type '24 tube, having a five-prong base, is used as a biased detector. In these sets, the newer '57 can be used as the detector provided the proper adapter is installed. This same adapter also can be used to replace the type '35 with a '58.

About a year ago, a new type of rectifier tube was developed. The '82 rectifier was designed to meet conditions present in new sets and although it looks like its predecessor, the type '80, in shape and internal construction, it has a 2½-volt filament instead of the 5-volt variety used in the '80. However, by means of an adapter, the '82 can be used in place of the '80. An external, built-in filament resistor cuts the 5-volt filament supply down to the required value. By using an '82 rectifier in place of the '80, increased filter voltage is obtained.

Adapters also have been developed that make possible tube substitutions in automobile receivers. The newer type '41 output tube, having a six-prong base, can be used in place of the five-prong '38. A change of this type, of course, makes a grid-clip connection necessary. However, a stud is provided on the side of the adapter to accommodate the grid clip taken from the replaced '38 and, as shown in the drawings on the opposite page, connects it internally to the grid of the '41.

Building a Crystal Set for the Children



By salvaging the coil and condenser from a discarded broadcast receiver, you can make an inexpensive crystal detector set

ALTHOUGH considered obsolete, the crystal receiver still has many uses. This is particularly true in sections close to large broadcasting stations.

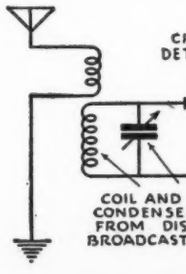
By building a crystal set, you can provide the children of the family with a cheap, satisfactory receiver of their own. Regardless of what programs the grown-ups want, the children can get the thrill of tuning in their favorite station on their own private radio set. As a matter of fact, a child can build a crystal set himself, if he is helped over the rough spots.

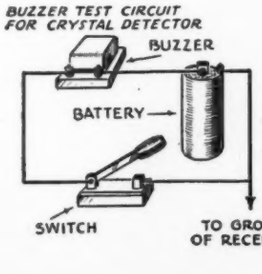
If you have an old broadcast receiver, the construction of a crystal set is greatly simplified. Merely remove the broadcast coils and condenser from the chassis and connect them together with a crystal detector and a fixed condenser according to the diagram below. Crystal detectors and earphones can be obtained from any dealer in radio parts.

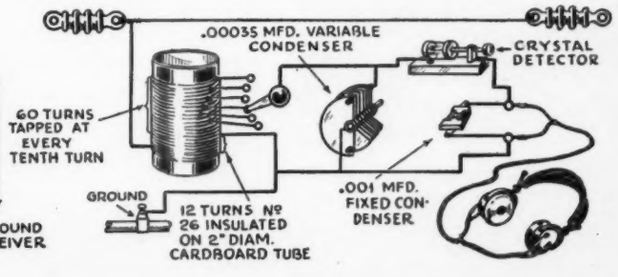
If you have a pound of No. 26 insulated wire, you can wind a receiver coil on a 2-in. diameter cardboard tube. The upper portion of the coil should be tapped at every tenth turn and connected to switch points on the panel. A movable switch arm then allows the effective length of the coil to be changed. The coil, seventy-two turns long in all, should be continuous.

If a crystal receiver is to work, the catwhisker, as the small wire contact on the detector is called, must rest on a sensitive spot on the crystal. To find a sensitive spot, connect in the buzzer-test circuit as indicated. With the buzzer on, move the catwhisker around until the buzzer is heard in the earphones. Since the catwhisker then rests on a sensitive spot, the buzzer can be shut off, and the receiver is ready for use. Then try each of the six coil taps in turn and tune the set with the variable condenser.

Within twenty-five miles of any large broadcasting station, a crystal receiver of this type should bring in fairly loud signals on the earphones. Of course, it will be necessary to use an antenna separate from the one serving the large electric receiver. For best results the antenna should be 100 feet long.

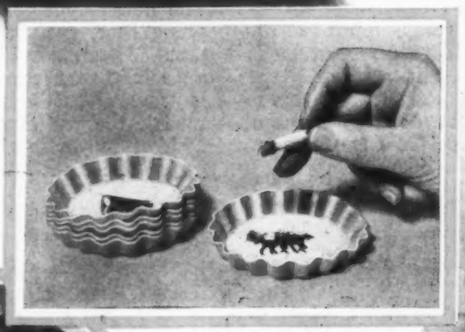





.00035 MFD. VARIABLE CONDENSER
CRYSTAL DETECTOR
60 TURNS TAPPED AT EVERY TENTH TURN
GROUND
12 TURNS Nº 26 INSULATED ON 2" DIAM. CARDBOARD TUBE
.001 MFD. FIXED CONDENSER

New Devices
FOR THE BUSY HOMEMAKER

NEW COCONUT SHREDDER. This new fruit juicer, which has a detachable reamer, can be quickly changed into a coconut shredder. It is easily demounted for cleaning



INDIVIDUAL ASH-TRAY. The tray, above, is of asbestos and is designed for individual use. When soiled it is thrown away. It can also be used as a coaster for glasses

REST FOR FLATIRON Illustrated in circle is a new flatiron rest that is attached to ironing board so iron slides onto it without the necessity for lifting it. One advantage claimed is that it leaves the board clear for work

SHELVES IN THE DOOR More food compartments are possible in this refrigerator since shelves are built into the door in which butter and fruit can be kept

KEYHOLE LIGHT The latest plan for illuminating the keyhole in a door is to have a built-in light so located that its rays fall on the hole. A button turns it on

KILLS THE MOTHS. Above and at right, are two views of a garment container that is designed to protect clothing from moths. A liquid chemical, put inside it, releases a killing vapor

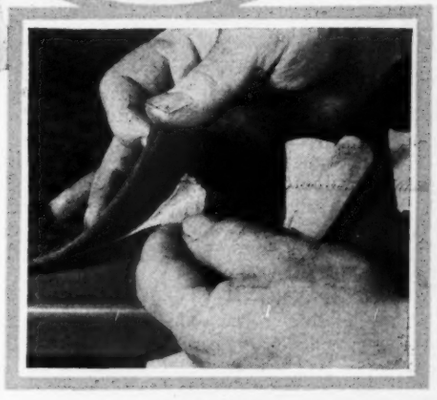
NEW STRAINER FITS ANY SPOUT Tea grounds cannot pass through the strainer, below, and it is said it will not drip. The claim is also made that it fits any spout

TWO WASHERS IN ONE. This washer has two compartments, either of which can be used independently. The smaller, for fragile garments, is also a dry cleaner

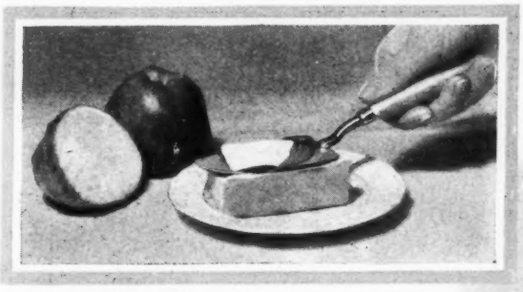
SPECIAL MILK HEATER Two compartments in the pot, left, make it impossible to scorch milk. The compartment over the flame is filled with water and the milk, in upper section, is heated by the water and so will not boil over

INVALID'S TABLE. Those who are convalescing may have the table, right, adjusted to any height they may like for eating, card playing, or as a convenient table for sewing

MIRROR IN SHAVING CUP In the top of this shaving cup is a mirror that can be adjusted to any angle desired by the user



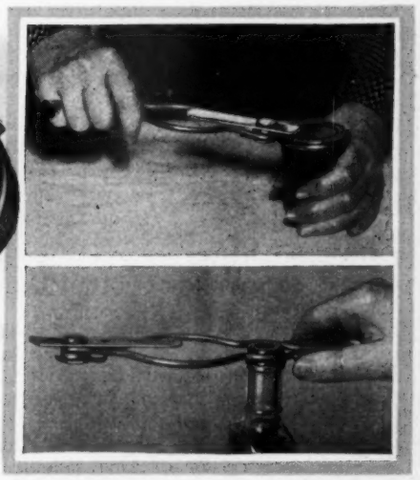
STAIR MATS HELD DOWN. Two adhesive pads on the outside corners of a stair mat hold it in place without at all marring the surface



SLICER HAS MANY USES. Cheese is either sliced or cut into squares with this slicer. It also can be used to slice apples for pies or sauce, or new potatoes for frying

OPENER ALSO SEALS BOTTLE. Caps are removed from bottles with the opener, below, which also seals them air tight

SAVES THE MEAT JUICE. There is no chance for meat juice to escape from this self-basting pressure cooker. It revolves while in use and the juice is dropped over the meat



OPENER FOR JELLY GLASSES. Tops are quickly removed from jelly glasses with the opener shown here. The center grip is for use in removing tops from catsup bottles

"Are you O.K.?" Gus asked as the driver, holding a handkerchief to his head, climbed out of the ditched car. "Yes, except for this cut," he said. "The windshield seemed to explode right in my face"

By MARTIN BUNN

Auto Glass *that's Crash-Proof*

BRAKES screeched and horns sounded as a blue sedan whizzed past the Model Garage tow car, cut in sharply to avoid a truck, and crashed through the white fence bordering the well-paved highway.

For a moment, Gus Wilson and his partner, Joe Clark, were speechless. Then Gus slid the garage car to a stop and both men hurried back to the wreck. The driver of the truck trotted toward them from the opposite direction.

"Are you O. K.?" Gus asked as a small man, holding a red-stained handkerchief to his face, climbed out of the ditched car and stood grinning sheepishly.

"Except for this cut," said the man, uncovering a gash over one eye. "The blamed windshield seemed to explode right in my face when I hit that fence. Guess I lost control. I didn't see that truck when I started to pass you."

"We'd better get you to a doctor," the truck driver put in. "Cuts like that are nothing to fool with."

"Aw, the cuts all right. How about the car?" he asked as he surveyed the wrecked machine in the ditch.

Aside from a shattered windshield and a badly crumpled fender and headlight, nothing vital appeared to be damaged. Gus Wilson bent the mangled mudguard clear of the wheel and climbed into the driver's seat.

"A busted windshield sure contains a heap of glass," remarked Gus as he carefully brushed the glass splinters from the seat. "The whole car's sprayed with it."

"You're telling me?" said the injured driver. "When I hit, that windshield just disintegrated. I'll be picking it out of my hair for months."

Gus carefully backed the car onto the road. "Joe," he said, "suppose you drive Mr.—er—"

"Kennedy," supplied the man. "Live just a few blocks from your garage."

"Suppose you drive Mr. Kennedy home in his car and I'll follow in the wrecker," continued Gus. "And if I were you, Mr. Kennedy, I'd see a doctor first thing. The car can wait. Bring it around tomorrow and I'll look it over. Probably all its needs is a new windshield and a little ironing out on that fender."

GUS was standing in the garage office doorway the next morning when Kennedy, patched and bandaged, arrived.

"Well, here I am," he called in answer to Gus's greeting. "Now that I'm all mended, I guess I'll treat the car to a few repairs."

"How's the cut?" Gus asked, indicating the bandage over Kennedy's eye.

"Fine. Doc says I'll have a scar, though. Had to take four stitches to close it up."

Gus drove the car into the repair shop and started a systematic inspection of the wheels, brakes, and steering gear.

GUS says:

You owe it to yourself, your family, and the other drivers on the roads to see that your car is as safe as you can make it. Steering gear failures, tire blow-outs, and poor brakes cause as many bad accidents as reckless driving. If you call yourself a safe driver, be sure your car's controls respond quickly. A fraction of a second's delay may mean a bad crash instead of a harmless scrape.

"Looks like your car got off easier than you did," he said as he tested the wheel bearings. "Outside of that busted windshield and folded fender, she's O. K. If that windshield had been as up-to-date as the rest of the car, you'd have escaped without a scratch."

"How come?" Kennedy asked.

Gus said nothing as he ambled across the repair shop and disappeared through the storeroom door. When he reappeared, he was holding two squares of glass.

"See any difference between these?" he asked holding out the two glass sheets.

Kennedy held the two samples to the light, looking first through one and then the other. "They look alike to me," he said, "excepting for the black strip along the edge of this one."

Gus propped the two sections of glass on the repair bench, picked up a heavy wrench, and stepped back about four paces. "Now watch," he said.

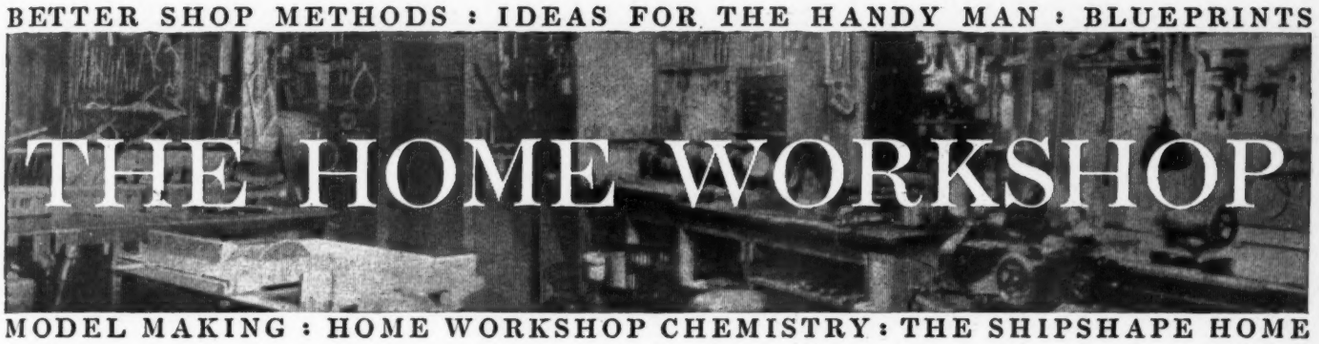
Swinging his arm in a wide arc, he flung the heavy wrench at one of the glass squares. Kennedy ducked as glass showered down on the repair bench.

"What did you expect it to do, bounce?" Kennedy said, obviously puzzled by the strange performance.

Without answering, the gray-haired mechanic tossed the wrench at the second square of glass. Cracks darted from the point where the tool hit, but the glass did not shatter. Instead, it held its shape as the wrench rebounded.

"Say!" exclaimed Kennedy. "I've seen shatter-proof glass before, but it was always brown and cloudy-looking. I thought those two pieces of glass were cut from the same sheet."

"If you'd had a windshield made of that stuff," said Gus, "you'd have saved a doctor's bill and a mean gash over your eye to boot." *(Continued on page 92)*

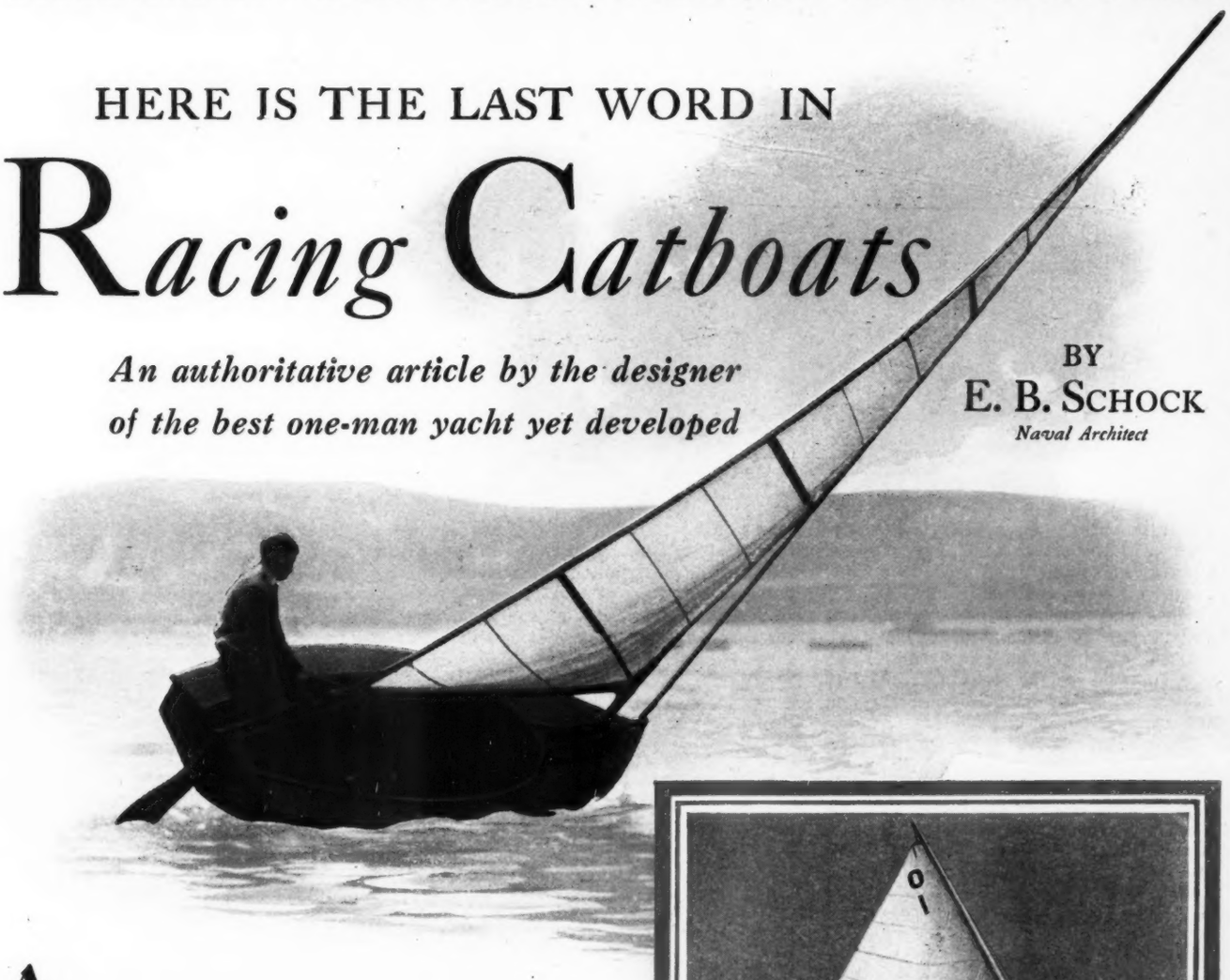


HERE IS THE LAST WORD IN

Racing Catboats

An authoritative article by the designer of the best one-man yacht yet developed

BY
E. B. SCHOCK
Naval Architect

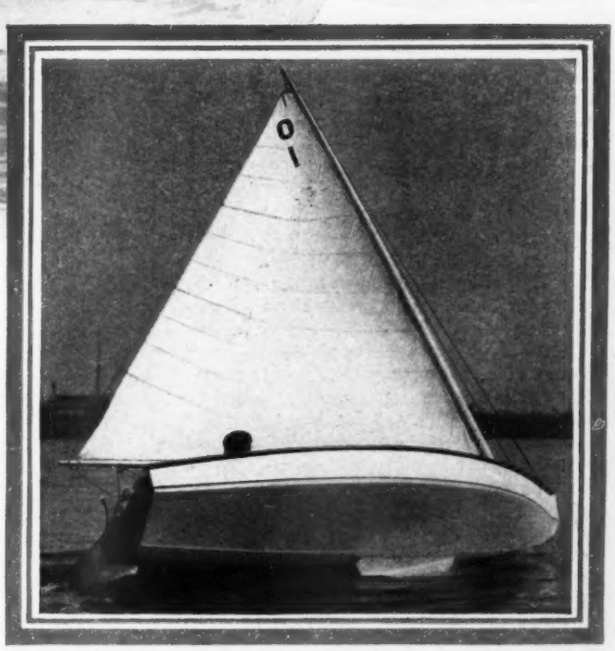


AMERICA'S most recent contribution to international racing, the Olympic monotype catboat, may be built from the accompanying plans for $75 or less, including a serviceable sail. This should help erase once and for all the popular fallacy that yachting is a game only for the rich.

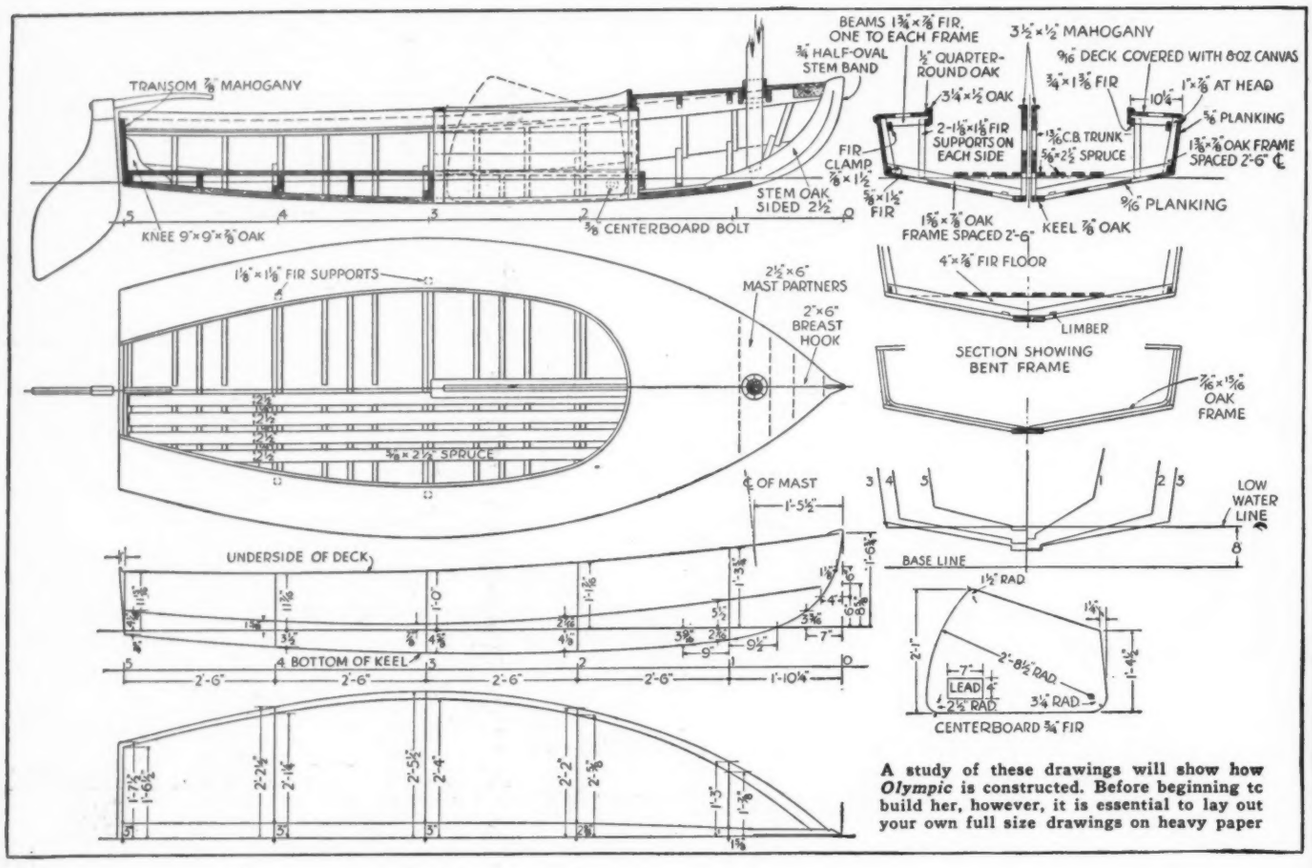
Redesigned from the Snow Bird class, so popular in California waters, for the American Olympic Committee and raced in the Olympic games at Los Angeles, Calif., *Olympic* represents combined efforts to produce a craft easily handled, of sturdy construction, and inexpensive. Her length is 11 ft. 11¼ in., and the extreme beam is 4 ft. 11 in. She is fast under sail, quick in response to the tiller, and can be used with an outboard motor.

You may suit yourself as to whether you build the framework right side up or upside down. *Olympic* may be constructed either way, though the plans can be followed more easily with the keel down.

At the outset you should lay her down full size on paper, preferably spread out on the floor of your shop or workroom. It will not be necessary, however, to make full size paper patterns, although you will find it valuable to outline the boat in every respect.



So quickly has this monotype catboat become famous that she is frequently seen in the movies and much has been published about her, but this is the first and only article to appear by the noted naval architect who developed the original plans



A study of these drawings will show how *Olympic* is constructed. Before beginning to build her, however, it is essential to lay out your own full size drawings on heavy paper

From the outline you will have a complete picture of the craft, enabling you to see wherein she differs from any other small boats you may have built.

Although anyone familiar with tools will be able to turn out a finished boat, careful study of the plans will enable you to build a craft that not only will have a more professional appearance, but will perform better in the water.

First make the form on which to set up the boat. Second, lay the keel on the form and put in the centerboard trunk. The finished keel, measuring ⅞ by 6 in. by 11 ft. 11½ in., may be cut from a single oak piece 12 ft. long, while the trunk pieces, of course, should be nailed together. The slot for the centerboard should be cut in the keel before the keel is set up.

After the keel has been installed, the headpieces of the centerboard trunk may be fitted by forcing two blunt ¼-in. bolts, 6 in. long, or galvanized wire nails of the same length, through the keel and headpieces.

The bed pieces of the centerboard trunk go in next. Of the two usual methods of construction, you will find it easier to drive in ¼-in. bolts 7 in. long from the bottom, but these must be countersunk at the top in order that the next section of the trunk may fit flush.

Three bolts or galvanized nails should be driven into each end of the headpiece to hold it fast. The other sidepieces of the centerboard trunk must be fastened right through with drift bolts long enough to enter at least 3 in. into the side next beneath. Bolts 7 by ½ in. will serve suitably, although wire nails can be made to do. These should be spaced 8 in. apart—a spacing suitable for calking. Since all seams, even the bottom one, are above the water line, not much water can come in through the trunk even though it be poorly calked.

Next, you should get out the stem. You can install the stem either before or after setting up the keel, though the latter probably will prove more simple. The same is true of the transom.

Fasten the stem to the keel with three 4 by ¼ in. bolts, and secure the transom to the knee with three ¼-in. bolts of

MATERIALS REQUIRED FOR BUILDING *OLYMPIC*

Centerboard, 2 pc. ¾ by 12 in. by 3 ft., fir.
Centerboard trunk, 2 pc. 13/16 by 6 in. by 3 ft. 6 in., and 6 pc. 13/16 by 4 in. by 3 ft. 6 in., all fir or redwood.
Frames, 4 pc. ⅞ by 1⅝ in. by 5 ft. or 8 pc. ⅞ by 1⅝ in. by 2 ft. 6 in., and 8 pc. ⅞ by 1⅜ by 12 in., oak.
Frames (bent), 1 pc. 15/16 by 4 in. by 3 ft. 6 in., oak.
Transom, ⅞ by 15 in. by 3 ft. 6 in., mahogany.
Planking (bottom), 12 pc. 9/16 by 6 in. by 13 ft., cedar or cypress.
Planking (sides), 4 pc. ⅝ by 6 in. by 13 ft., cedar or cypress.
Deck, 6 pc. 9/16 by 4 in. by 10 ft., spruce, cedar, or cypress.
Deck beams, 2 pc. ⅞ by 12 in. by 4 ft., fir.
Coaming, 3 pc. ½ by 3¼ in. by 6 ft. 3 in., oak.
Chine, 2 pc. ⅝ by 1½ in. by 13 ft., fir.
Keel, 1 pc. ⅞ by 6 in. by 12 ft., oak.
Clamp, 2 pc. ⅞ by 1½ in. by 13 ft., fir.
Carling, 2 pc. ¾ by 1⅜ in. by 10 ft., fir.
Floors, 4 pc. ⅞ by 4 in. by 4 ft., fir.
Floor boards, 8 pc. ⅝ by 2½ in. by 10 ft., spruce.
Stem, 1 pc. 2½ by 10 in. by 3 ft., oak.
Centerboard cap, 1 pc. ½ by 3½ in. by 3 ft. 6 in., mahogany.
Rub strake, 2 pc. ¾ by 1½ in. by 13 ft., fir.
Rudder, 1 pc. 1⅛ by 16 in. by 3 ft. 6 in., mahogany.
Mast (solid) 1 pc. 3⅛ by 3¼ in. by 21 ft., spruce; or (hollow) 2 pc. 1⅝ by 3⅛ in. by 21 ft., spruce.

FASTENINGS

¾ gross 1½-in. No. 8 F. H. (flathead) brass screws.
½ gross 1¼-in. No. 8 F. H. brass screws.
1 doz. 2½-in. No. 10 F. H. brass screws.
3 doz. 1-in. No. 8 F. H. brass screws.
2 doz. 1¾-in. No. 10 F. H. brass screws.
4 doz. 1½-in. oval-head brass screws.
3 doz. 1¾-in. No. 12 galvanized screws.
2 doz. 1¾-in. No. 12 gal. screws, or 1 doz. screws, 2 doz. 2 by ¼ in. carriage bolts.
4 doz. 1½-in. No. 8 gal. screws.
4 lb. fourpenny common gal. nails.
3 lb. threepenny copper wire nails.
½ lb. 1-in. gal. brads.
1 lb. sixpenny common gal. nails.
2 lb. fourpenny copper wire nails.
1 lb. ⅜-in. F. H. copper tacks.
4—7 by ¼ in. stove bolts.
1—2 by ¼ in. eyebolt.
15 lb. lead (for centerboard)
2—6 by ¼ in. bolts.
6—7 by ¼ in. bolts.
(NOTE: All galvanized screws should be countersunk; brass screws may be set flush.)

HARDWARE AND FITTINGS

1—6 by 5/16 in. turnbuckle.
1 No. 1114 screw eye.
2—⅜-in. gal. blocks (pulleys), fast eye.
1—⅜-in. gal. deck block.
2—No. 2 gal. rudder braces or hangers.
1—4 by ⅜ in. gal. eyebolt; 1—3¼ by ⅜ in. screw ringbolt, and 2—6-in. gal. cleats.
12—4-in. gal. iron mast rings.
½ gross brass grommets.
21 ft. ⅜-in. bronze sash cord or rigging cable.
100 ft. ⅜-in. manila rope.
1½ qt. marine glue.
97 sq. ft. 6-oz. cotton sail twill, and enough 8-oz. canvas to cover the deck.
2 lb. putty and 2 lb. white lead, mixed equally; and ½ lb. cotton calking.
1 pc. 4 ft. by ⅝ in. half-oval gal. iron.
1—3 by ¼ in. brass centerboard pin.
Paint, varnish, and shellac.

suitable lengths. These should be forced through both the knee and the keel.

You now are ready to get out the four frames. Although, of course, they should be cut to shape in advance, you must take the pieces forming each frame, lay them down on the full size paper drawing, and clamp them tightly together at the chine. With the clamp in place, bore and bolt the pieces together with two 2 by ¼ in. carriage bolts. The bevel required can be determined from the full size drawing before you install the frames in the boat.

Meantime, the limber holes for the chine log may be cut. This may be done easily by sawing down ½ in. and cutting out the 1 in. long segments with a chisel.

As the next step, you should fasten the floors to the frame, using four 2 by ¼ in. carriage bolts in each end, after having cut limbers through the floors as through the frame. Now, not before, is the time to put in the frames, a simple but important step in boat building. Stay lathes made from light, scrap material should be nailed across their tops to keep them from collapsing.

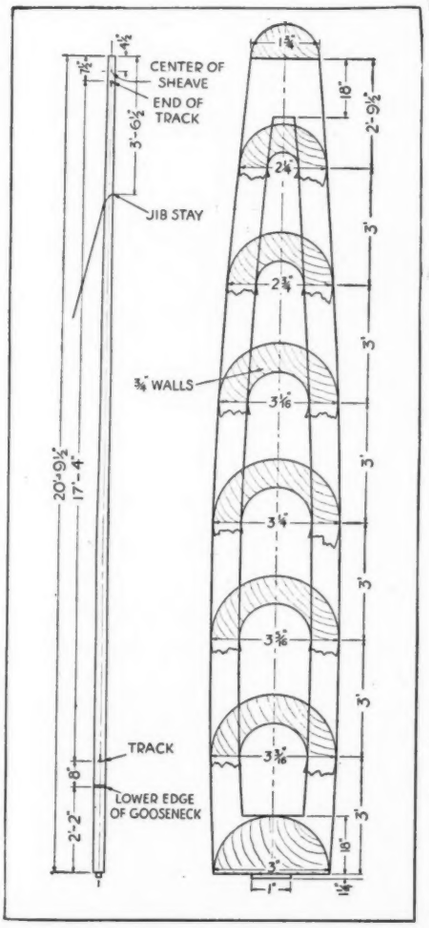
When the frame is in the boat, put in the clamp and chine log. The clamp should be fastened by a 2 by ¼ in. bolt through the frame, one bolt to each frame. At the same time put in the chine log, securing it with galvanized wire nails, one to each frame.

Start your planking, using fir or cedar. By obtaining the size specified in the bill of materials, you will find the lumber comes about the right length. You should begin with the strake adjoining the keel, clamping it tightly in place to make a neat fit with the calking edge. Then fasten the strake to the frames, using two 1¼-in. No. 8 brass screws to each frame. Duplicate this procedure with each board on out to the chine.

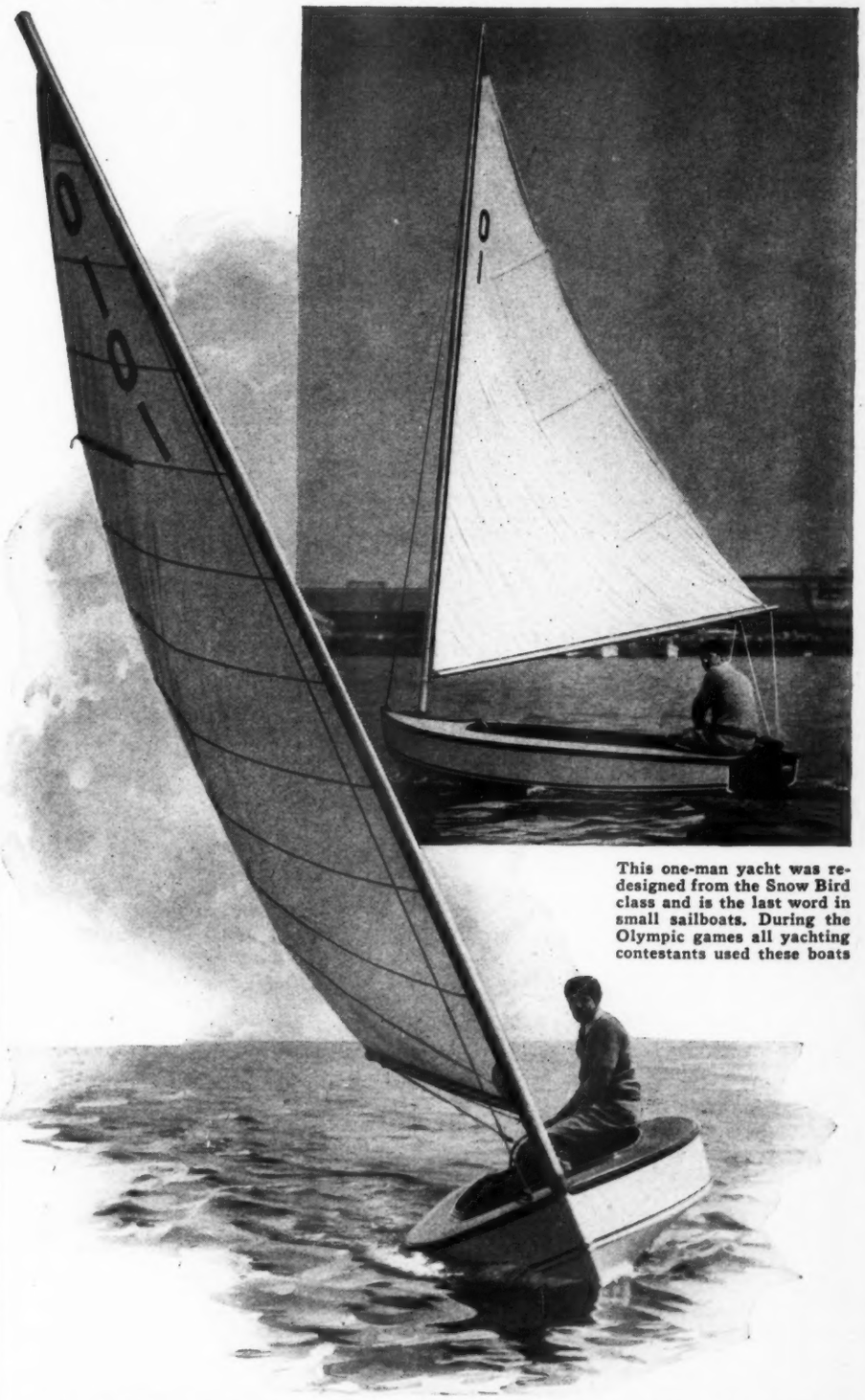
You will have less trouble getting a proper bevel at the chine if the bottom planks are put on first. The only method of obtaining a good bevel is to fit it several times, looking at it from both the inside and outside at each of the fittings.

The same material used in the bottom should go into the sides. Before putting on the side planks, install the deck beams. At the same time fasten the four fir supports, followed by the carling. Use four-penny galvanized nails, one in each beam. The deck beams should be fastened to the fir clamp by galvanized wire nails, their size and length to be determined by your own judgment. Secure the side planks in the same way you put on the bottom planks.

In installing the bent frames, which for combined lightness and strength should be cut 7/16 by 15/16 in. from oak, stop ¼ in. short of the center line of the keel to form a limber. *(Continued on page 93)*

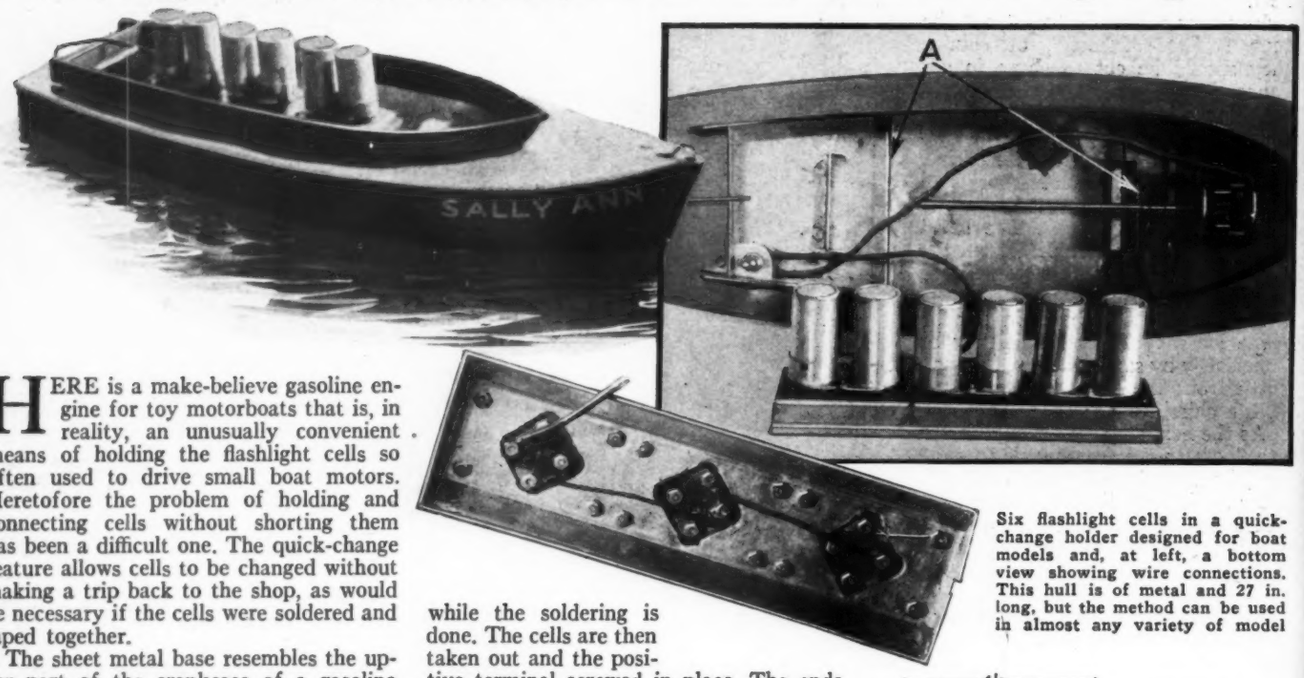


The mast may be made solid or, as shown in the detail drawing, from two pieces hollowed out in the center and glued securely together



This one-man yacht was redesigned from the Snow Bird class and is the last word in small sailboats. During the Olympic games all yachting contestants used these boats

Flashlight Cells in Motorboat Model Look Like Racing Engine



Six flashlight cells in a quick-change holder designed for boat models and, at left, a bottom view showing wire connections. This hull is of metal and 27 in. long, but the method can be used in almost any variety of model

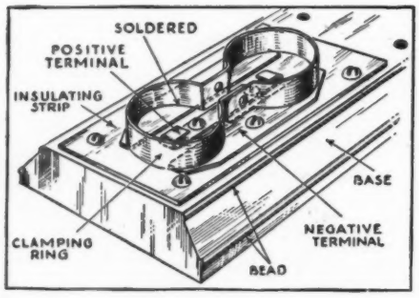
HERE is a make-believe gasoline engine for toy motorboats that is, in reality, an unusually convenient means of holding the flashlight cells so often used to drive small boat motors. Heretofore the problem of holding and connecting cells without shorting them has been a difficult one. The quick-change feature allows cells to be changed without making a trip back to the shop, as would be necessary if the cells were soldered and taped together.

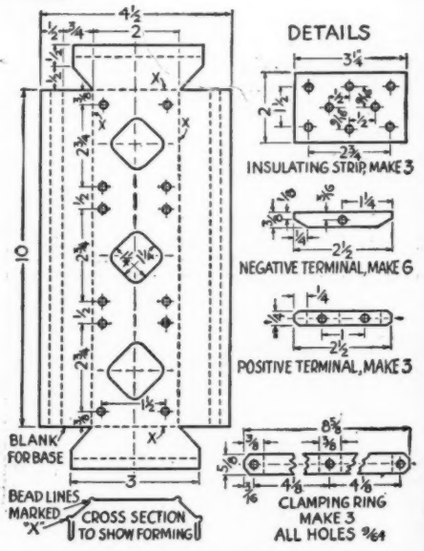
The sheet metal base resembles the upper part of the crankcase of a gasoline engine, and the cells suggest the cylinders. The cells are connected in series-multiple: two cells in multiple and three pairs in series. This gives 4½ volts at twice the capacity of a single cell.

The base is supported by two uprights, marked *A* in one of the photographs, that fit just inside the base at each end. The length of these supports, shape of lower ends, and method of attaching to the hull will depend on the kind and shape of the hull.

Details of the parts are given in the drawings. The base and clamping rings may be of tin plate. The insulating strips may be 1/16-in. bakelite, fiber, or celluloid. The negative terminals may be 18-gage galvanized steel or 1/16-in. brass. The positive terminal may be of spring bronze, cut from weather strip. The clamping rings should be bent into shape around the bottom ends of two cells, and the clamping screw put in place. The negative terminals should then be screwed down, the rings being held in place on them while the soldering is done. The cells are then taken out and the positive terminal screwed in place. The ends of the latter should be bent up as shown in the assembly drawing.

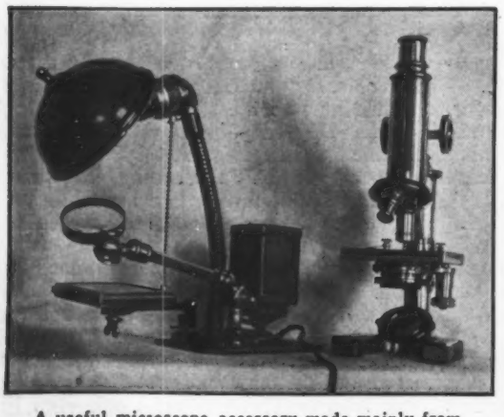
When the top ends of two cells are pushed down into the rings, the center terminals make contact with the positive terminal, and the zinc cases are in contact with the negative terminal. The clamping is accomplished by tightening a machine screw, which passes through the holes in the clamping rings. All machine screws are No. 6/32.—R. W. WAGNER.




DETAILS
INSULATING STRIP, MAKE 3
NEGATIVE TERMINAL, MAKE 6
POSITIVE TERMINAL, MAKE 3
BLANK FOR BASE
BEAD LINES MARKED "X"
CROSS SECTION TO SHOW FORMING
CLAMPING RING MAKE 3 ALL HOLES 9/64

Details of the base and other parts and, at left, a drawing showing an assembled unit

Inexpensive Four-in-One Unit Helps Beginners Do Better Microscope Work



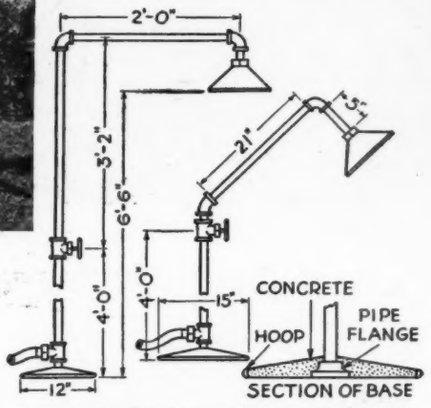
A useful microscope accessory made mainly from odds and ends. It includes understage and overstage lamps, a turntable, and an adjustable glass

Now that the microscope has become so popular, some readers may wish to construct this compact combination outfit consisting of (1) an adjustable understage light, (2) an adjustable reading glass, (3) an adjustable dissecting turntable, and (4) an adjustable above-stage light. The understage light is of a well-known standard make, mounted on a rear-view automobile mirror. The flexible lamp standard and socket are from an old desk lamp. The reading glass support is made from electrical fittings purchased in the "five and ten." The turntable dissecting platform is an old tin frame with a glass top and green felt underneath. The felt is glued to a block of wood, which is drilled and fastened to the pivot screw going through the end of the arm that supports the turntable.—OSCAR FREEMAN.

LAWN SHOWER KEEPS CHILDREN COOL

A LAWN shower bath for children can be made at small expense as shown in the accompanying illustrations. This fixture may also be placed beside an ordinary bathtub and connected to the mixing faucet by a short hose, or it can even be used near a floor drain in the basement by connecting it to the hot and cold lines through a Y and a hose connection.

The base is a pipe flange cast in a circular concrete block or fastened to a flat board or an iron casting. The standard is made of ½-in. galvanized pipe and standard galvanized fittings. A regular shower head can be used or a cheap one purchased at the ten-cent store, or a hose sprinkler head will do very well for an outdoor shower. The cost of materials to make the one illustrated was $1.94.—EARL D. HAY.



Suggestions for homemade shower fixtures, and a photograph of one that cost only $1.94

CAMP WASHTUB MADE FROM CRACKER BOX

CLEANLINESS in camp is made easy with this combination washboard and tub, which also serves as a compartment to carry canned goods, cooking utensils, or other equipment while traveling.

Obtain a large tin cracker box from your grocer and have a tinsmith make a corrugated zinc washboard with a metal edging to prevent cuts and tears in the clothing. It should be hinged inside the box lid as shown. It will be seen that the board is hinged in such a way that the water runs back into the box. After use as a washtub, the box should, of course, be dried thoroughly to prevent rusting.

The cost for the box and washboard was only $1.25. Its assembly was completed at home.

Motorboat owners and occupants of one-room apartments also may find use for the idea.—CLIFFORD PARK BALDWIN.

LYE ETCHES DESIGNS ON ALUMINUM

You can improve the appearance of aluminum articles by etching decorative designs in the metal with a strong alkali solution. Wherever the fluid touches the metal, it produces a beautiful matte surface that contrasts strikingly with the usual polished finish of aluminum pitchers, syrup dispensers, aquarium frames, and the like.

Coat the area to be decorated with a paraffin film a few thousandths of an inch thick. This is done by heating the metal slightly and then rubbing it with a piece of the wax. Reheating will distribute the paraffin evenly.

Draw the design on a piece of paper and outline it with pinholes spaced fairly close together. Lay the paper over the waxed surface of the aluminum and go over the design with a piece of cloth moistened—but not wet—in gasoline or benzine. Let the liquid evaporate and then remove the paper. The design will be outlined by a series of tiny dots where the gasoline came in direct contact with the coating. Although not prominent, the dots can be seen plainly enough to be used as a guide in removing all the wax from the areas to be etched.

Use a sharp, slender knife to scrape the wax from the metal. You can make a suitable tool by thrusting a needle eye-first into a wood handle and then grinding the other end so that a sharp, diagonal edge is produced. Be sure to remove every trace of wax from the aluminum wherever you want the alkali to act.

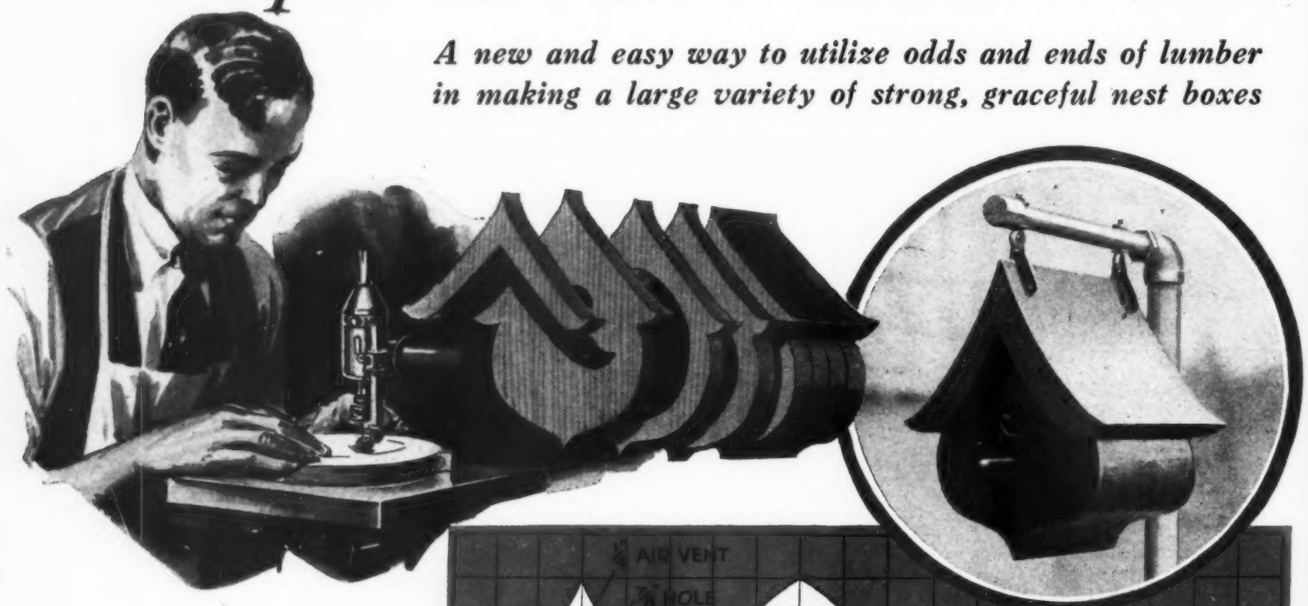
Make the etching solution by adding a teaspoonful of water to an equal quantity of washing lye. This produces a thick liquid that you must keep from your fingers and clothes. Apply it to the aluminum with a piece of cotton wrapped around a stick, being careful not to touch parts of the article where no design is desired and which are not protected by wax. Etching will require from 5 to 30 minutes, depending on the depth desired, strength of the lye, and other conditions.

Finally, wash the lye off with clean water and remove the protective paraffin coating by pouring boiling water over it. No further treatment or finishing is required.—WALTER E. BURTON.

At left: **Transferring the design to a waxed surface.** ***Above:*** **Etching the aluminum with lye.** ***In oval:*** **The decorated aluminum syrup pitcher**

Unique BIRD HOUSES

A new and easy way to utilize odds and ends of lumber in making a large variety of strong, graceful nest boxes

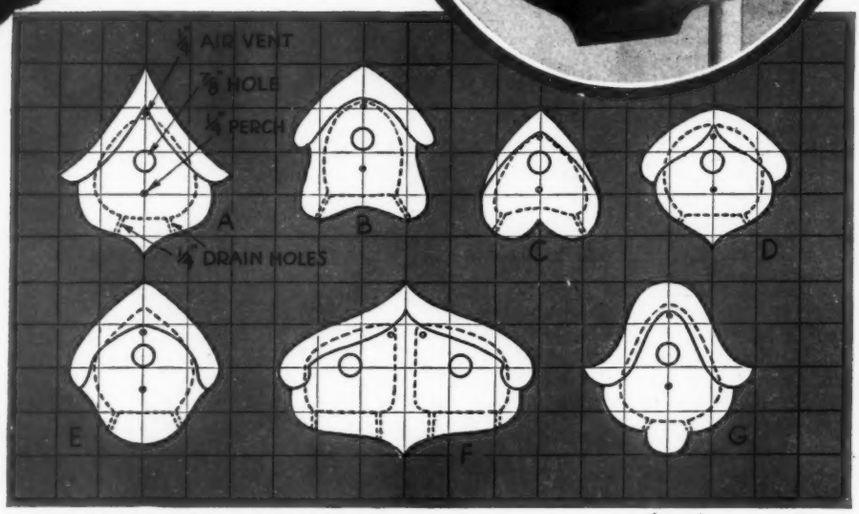


By ERNEST V. BAKER

IF A BIRD house made on a jig or scroll saw was merely just as good as a bird house constructed in the conventional board-saw-hammer-and-nail method, then it would be worthy of little note. However, try one of these houses on your jig saw and I'll wager the sale of nails for bird-house purposes in your neighborhood will take a slump.

The inexpensiveness of material, the simplicity of construction, the beauty obtainable, the durability, and the unlimited variety of designs which can be worked out are unique features of this system.

The first step in making any of the houses shown is to lay out on a piece of cardboard the full-sized front view, using the 2-in. squares as a guide. Cut out the pattern, following the outside line and the line of the nesting cavity.



Above: Seven wren-house designs drawn on 2-in. squares, and a photo of the first house. *Right:* House for bluebird, titmouse, chickadee, nuthatch, swallow, or downy woodpecker

A NEW SERVICE

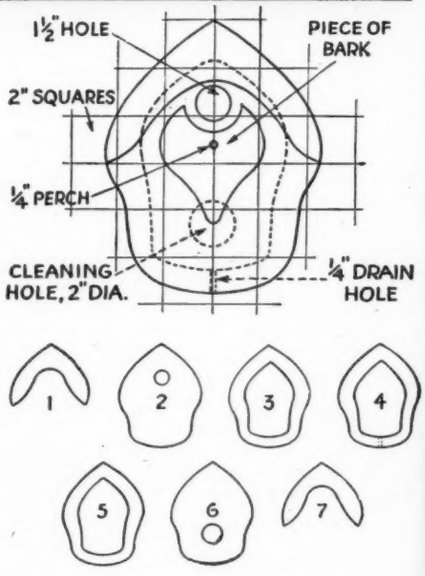
FULL-SIZE PATTERNS
for Three Bird Houses

DO YOU find it difficult to understand mechanical drawings and to lay out your work accurately? Many readers do, and for that reason they are handicapped in taking up craft work. What they need to give them a good start are full-size patterns as easy to follow as the patterns sold for making women's clothes. POPULAR SCIENCE MONTHLY has prepared patterns of this type for three bird houses—the wren house marked *G* in the group above, the larger house immediately below it, and the still larger woodpecker house on the opposite page. All three will be sent for 25 cents. Use coupon on page 80.

Next, the material should be selected. Paying no attention to the kind of wood or its quality, pick out as many pieces as you can find with a thickness of from ½ to 2½ in. on which the pattern will fit. If necessary, you can use a board which is twice as long as is required but only half wide enough by sawing it in two, gluing the edges together, and clamping until set. The glue used should be of the absolutely waterproof variety such as a good casein glue.

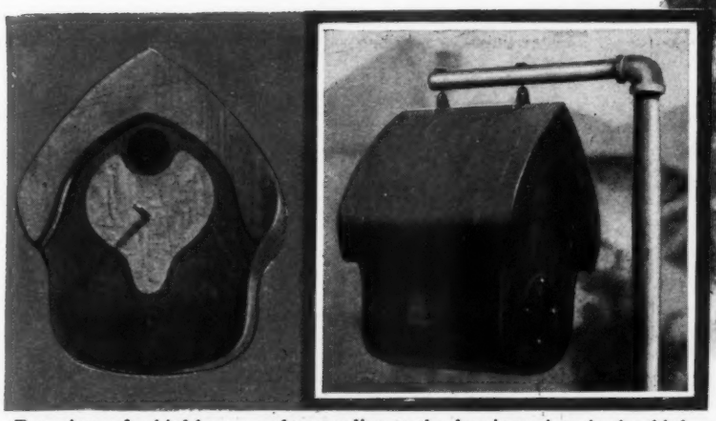
The marking of the sections is now in order. The house shown at the right will be used as an example. This house has a nesting cavity depth of 5 in. To make the required depth, select as many of your thickest pieces as are necessary to give a total thickness of 5 in. or a little over. In the house shown, three pieces slightly less than 1¾ in. thick were used. On these sections fasten the pattern down with thumb tacks and mark around both the outside and inside.

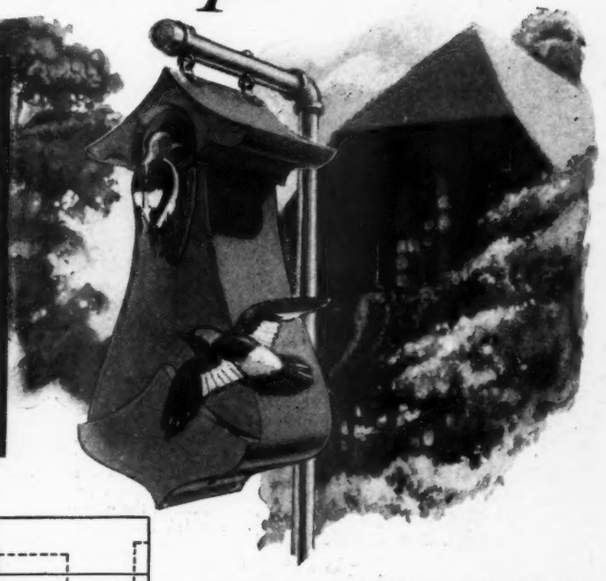
Select two pieces not over 1 in. thick for the front and back sections. Fasten the pattern in the same manner as before and mark around the outside only. Also mark the entrance hole on the front section and a 2-in. cleaning hole on the back section.



The eaves should now be marked on smaller pieces of wood. Their upper edges

Jig-Sawed *from* Scraps





Two views of a bird house made according to the drawings given in the third column of the facing page. Note the metal cover screwed over clean-out hole

House for red-headed or golden-fronted woodpeckers and, at left, the working drawings and small diagrams showing the parts

Prize Winners

IN OUR

Novelty Jig-Sawing CONTEST

"WHAT novelties besides picture puzzles can be made with a jig saw?" was the question we recently asked our readers in announcing a jig-sawing contest (P.S.M., Mar. '33, p. 63). Many excellent suggestions were received. These were rated by the judges on the basis of 50 points for novelty, 25 for craftsmanship, 15 for simplicity, and 10 for presentation. Prizes have been awarded as follows:

●

FIRST PRIZE, $25
Ernest V. Baker, Lafayette, Ind.

SECOND PRIZE, $15
Bill Chaney, Wakefield, Mich.

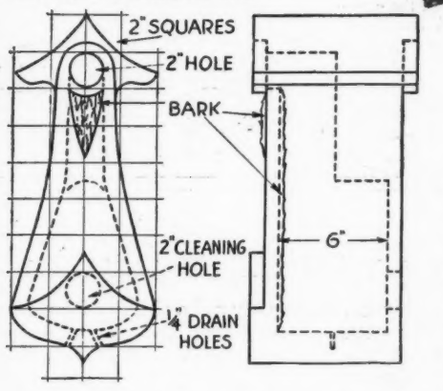
THIRD PRIZE, $5
Thomas B. Owens, Cleveland, Ohio

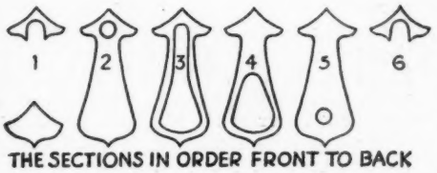
FIVE PRIZES, $1 EACH
D. C. Marshall, Manhattan, Kans.; Hugh Mullikin, Seattle, Wash.; Robert Putzer, Oshkosh, Wis.; E. J. Creighton, Leavenworth, Kans.; Theodore Jeffries, Newark, Ohio.

HONORABLE MENTION—*Carl W. Beese, Tavistock, Ont., Canada; W. E. Caswell, Mansfield, Pa.; Robert B. Dods, Kansas City, Mo.; D. Edelmann, St. Louis, Mo.; Virn M. Guilday, Rhinelander, Wis.; Merl Jones, Mason City, Iowa; W. B. Powell, Indian Springs, Ga.; F. L. Reuter, Wausau, Wis.; Dail L. Skaggs, Clinton, Tenn.; Jay W. Sload, Palmyra, Pa.*

●

The first-prize contribution is published this month, and several others will appear in following issues as space permits.





THE SECTIONS IN ORDER FRONT TO BACK

should be marked with the same pattern as has been used for the main sections, but the underside should be marked with another pattern made of paper. There is no need for great accuracy in this case.

With the sections all marked, place an "X" on each where it will remain after the surplus is cut away. Small inaccuracies in the pattern will make no difference if the sections are put together with the "X's" all facing one direction.

Now for the cutting. Drill a ¼-in. hole near the line in the waste part of the wood on the sections where an inside cut is necessary, namely, the cavity of the central sections and the entrance and cleaning holes. Threading a fairly heavy saw through one of these holes, fasten it in your jig saw and cut out the inside portion marked. Having finished all the inside cuts, cut accurately around the outside lines.

If the house requires bark on the inside and outside of the front section, such as the house being described and also the woodpecker house shown above, the inside bark should be put on next. Fasten the bark with casein glue and small brads.

The sections are now ready to be assembled. After making sure that the "X's" all face in one direction, glue each surface of adjoining sections where they come together. Line up the sections accurately and then clamp the whole assembly.

When the house has been taken from the clamps, any irregularities in the surface can be removed with very coarse sandpaper and the edges rounded very slightly. Fill any holes or cracks with a waterproof crack filler.

Now bore the drain hole or holes in the bottom. Fasten the bark to the front of the front section, if the plans call for it, and insert the perch.

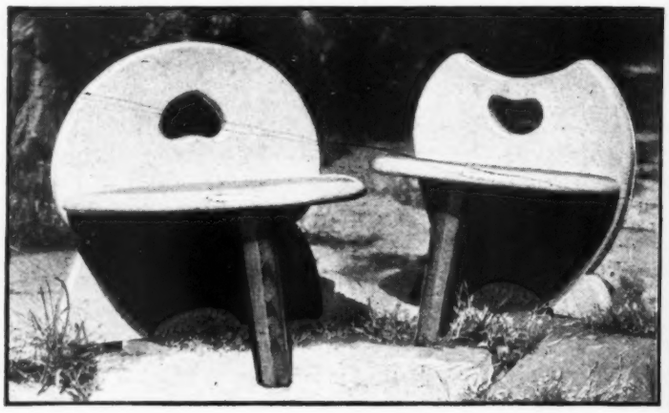
A simple pair of brackets for suspending the house can be made from strips of metal. Using a metal cutting blade on your saw, cut out two strips of sheet copper, aluminum, or brass 4 in. long and ½ in. wide. Fold these in the middle to form double strips 2 in. long. Bore a small hole ½ in. from the folded end for the supporting wires or eyelets, and another ½ in. from the opposite end for the ½-in. screws which fasten the brackets to the roof of the house. Put the folded end of the strips in a vise up to 1 in. from the open end and spread these open ends apart until the angle conforms to the gable of the house. Screw them to the roof.

The houses shown had one coat of shellac and two coats of varnish stain. However, every craftsmen has his own ideas on how a bird house should be finished, so this will be left to the individual taste. At the same time that you finish the house, put a similar finish on one side of a metal disk 3 in. in diameter. This disk should have four holes for screws bored ¼ in. from the edge and spaced equidistant around the circumference. After the finish has dried, screw the plate over the cleaning hole, using small screws.

Hang the bird house up, preferably facing south or east, and it's ready for the first tenant.

CHILD'S CHAIR NEEDS ONLY THREE PIECES

Unique little seats designed especially for children's use in the garden



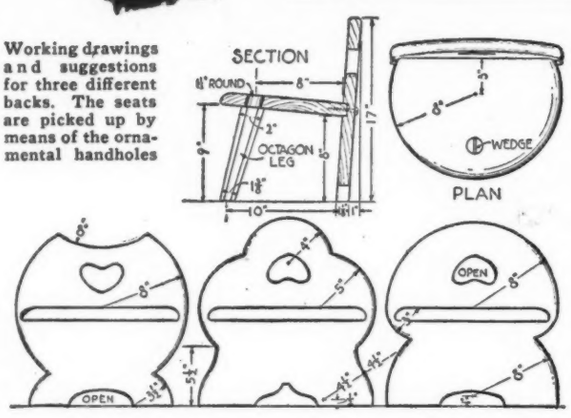
REAL usefulness is combined with economy in these ingenious stools. They were designed for children, but from the way in which they are appropriated by grown-ups at every opportunity—well, possession counts nine points in the law!

The materials required are few: For each stool allow one piece 16 in. wide by 17 in. long for the back, and one piece 12 in. wide by 16 in. long for the seat; these should be 1⅛ in. thick. Also obtain a 12-in. length of wood 2 in. square for a leg, and three 2½-in. screws for attaching the seat and back. If wide stock is not available, put two pieces together with waterproof glue and corrugated fasteners.

The essential tools are a compass saw, an expansion bit or large auger, knife, chisel, wood file, and a light plane. A compass is handy for laying out the work, but a makeshift—even a nail and a piece of string—can be made to answer the purpose.

Three different designs for backs are shown, but all have the same quaint, squat proportions. There is nothing in constructing the chairs to tax the ability of even an amateur. Making the legs will probably require the most time. First lay out the octagons at the top and bottom, making allowance for the taper. After the leg has been shaped, cut a round tenon on the upper end, making it fit the 1½-in. hole bored in the seat. With only a knife, a wood file, sandpaper, and patience, this tenon can be shaped to fit almost perfectly. Make this joint tight, but do not force it enough to split the seat. Secure the leg by driving in a thin wedge as shown in the plan view. To prevent splitting, locate the wedge so that it is across the grain of the seat. Of course, if a lathe is available, turned legs may be substituted for the ones shown.

Working drawings and suggestions for three different backs. The seats are picked up by means of the ornamental handholes

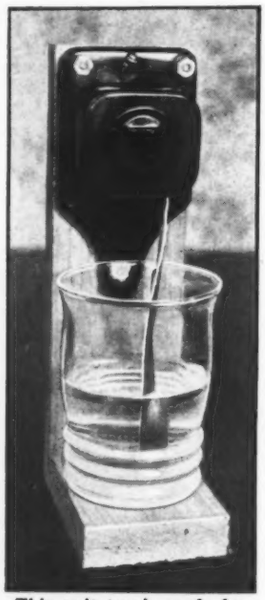


A groove about ½-in. deep is chiseled in the back to take the straight edge of the seat. Shape the groove at the ends to fit the bull-nosed edge of the seat neatly. Fasten them together with three 2½-in. screws. Good glue, of course, helps to make strong joints.

Any easily worked wood may be used. The stools shown in the photograph were made of white pine, and the legs of redwood. As they were intended mainly for outdoor use, they were given two coats of enamel (bright yellow), and the legs were finished in their natural color with two coats of boiled linseed oil. For indoor use, as fireside stools, leave the wood natural, using half oil and half turpentine. If you wish, give them an antiqued appearance by rubbing in a touch of burnt umber or other brown pigment here and there.—JAMES THOMAS.

CHEAP AGITATOR FOR CHEMISTS

IN CHEMICAL work it is often necessary to agitate various chemicals. This constant agitation may be required either to bring about a reaction or to insure a perfectly homogeneous mixture of whatever ingredients are being used. The instruments sold for this purpose, although convenient and well designed, are expensive, and for that reason the writer devised a little machine that employs an old electric bell. This is illustrated at the right. The gong was removed and a sheet metal paddle soldered to the end of the clapper arm. When used with a 6-volt bell-ringing transformer, this little agitator serves its purpose almost as well as commercial apparatus.—B. C.



This agitator is made by soldering a small metal paddle to the clapper arm of a common electric bell

FENCING IN THE STAKE FOR HORSESHOES

BY CUTTING the side walls of old auto tires at intervals of about 6 in. and straightening them out, it is possible to place them as a protection over the wooden retaining walls that are commonly set around the stake used in the game of horseshoes or quoits. The tires will last much longer than the unprotected wood, which is soon torn to bits.

Old tires protect the wooden retaining strips from the shoes

Bath-Robe Cord

KNOTTED IN SPIRAL DESIGN

By Kenneth Murray

Stretching the completed cord

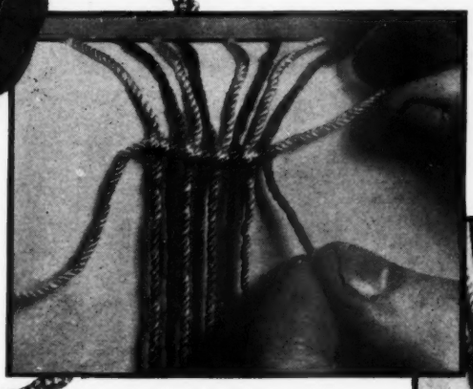
THIS new bath-robe cord is knotted in a way different from that commonly used. It is easy to make, yet distinctive and novel in appearance, and it has durability beyond all ordinary requirements. Silk cable cord and ordinary slipknots like those used in making the wampum belt described in a previous article (P. S. M., May '33, p. 63) are employed. The colors used are, of course, optional.

For a cord similar to that illustrated, four 30-ft. lengths of blue and four of light gray are needed, also one 40-ft. length of light gray for a filler cord. Half of each length is tied up in a hank, because the knotting starts at the middle. After making a row of knots over the filler cord with all eight strands, the ends of the row are brought together and the knotting is continued in spiral fashion. The blue and gray cords will automatically become spiral in design, giving a sort of ridged barber-pole effect.

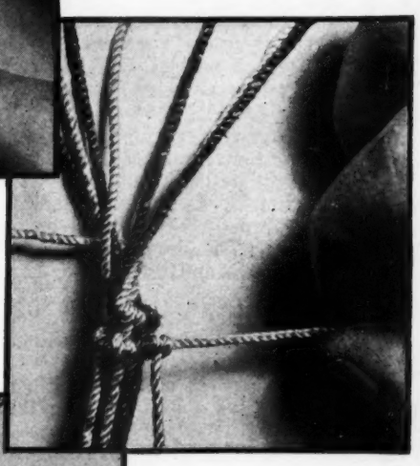
After 27 in. of the cord have been knotted, the work is reversed and another length of 27 in. is made from the middle. Then grasp the cord at the ends and pull as illustrated above. It should stretch out uniformly and easily to the required length of 6 ft., and thereafter will remain that long.

Instead of finishing the ends with tassels, pieces are made in the shape of open arrowheads over forms bent from wire. Common bailing wire is suitable. The illustrations show how these wire forms are covered. The center strip inside each arrowhead is knotted in the same manner as the wampum belt.

For other articles besides that mentioned on the wampum belt, see P.S.M., Nov., '32, p. 77, Mar. '33, p. 68, Apr. p. 75, and June p. 82.

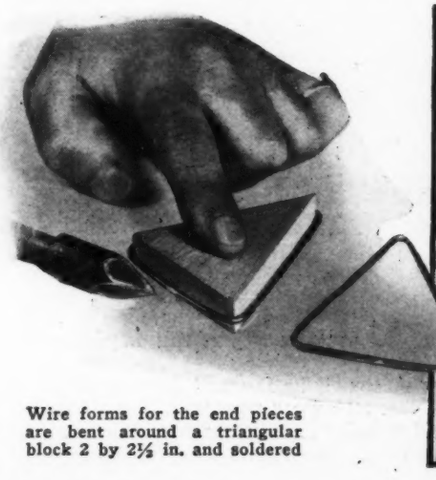


The knotting is begun at the middle, and a ruler is laid over the cords as shown at the left to keep them separated, with the colors alternating. Then a row of double slip knots is tied around the filler cord, which runs from left to right

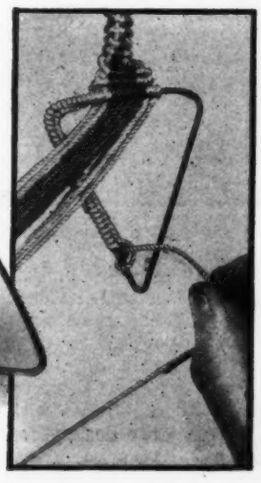


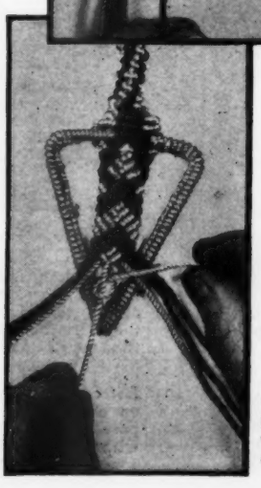
The ends of the first row of knots are brought together, and the knotting is continued. The two colors will automatically become spiral

When several inches have been completed, the spirally knotted cord will appear as at the left. It will be about as thick as one's little finger



Wire forms for the end pieces are bent around a triangular block 2 by 2½ in. and soldered

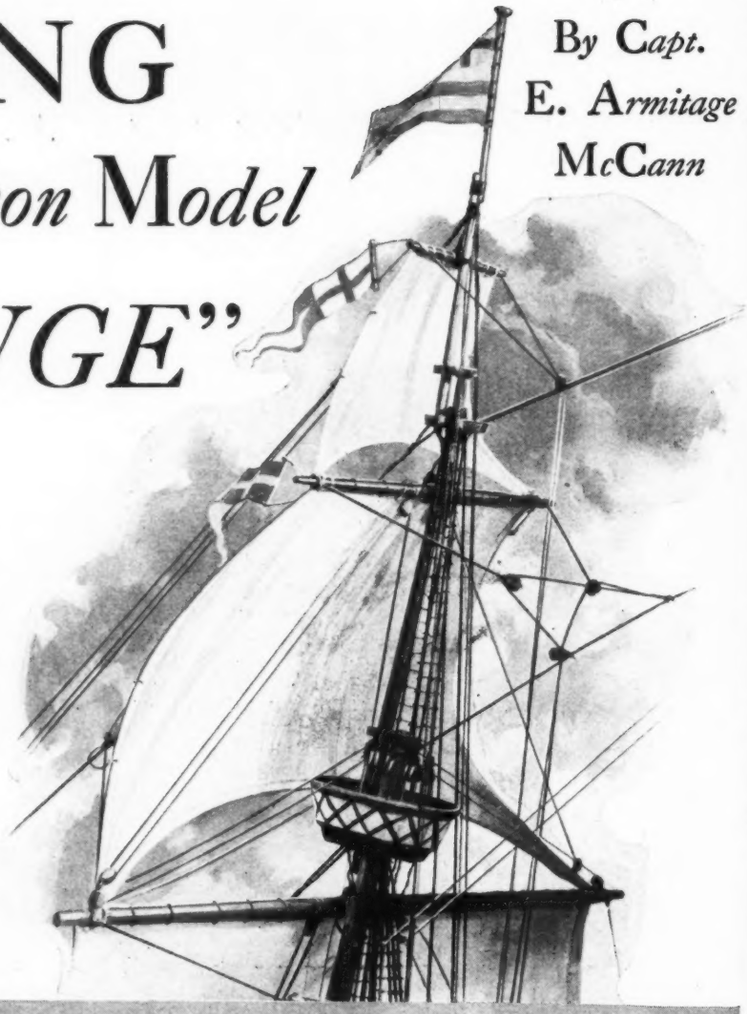




The photos at left and above show how the cords are knotted over the wire form, how the form is covered, and how the flat section is knotted

RIGGING
Our New Galleon Model
"REVENGE"

By Capt. E. Armitage McCann

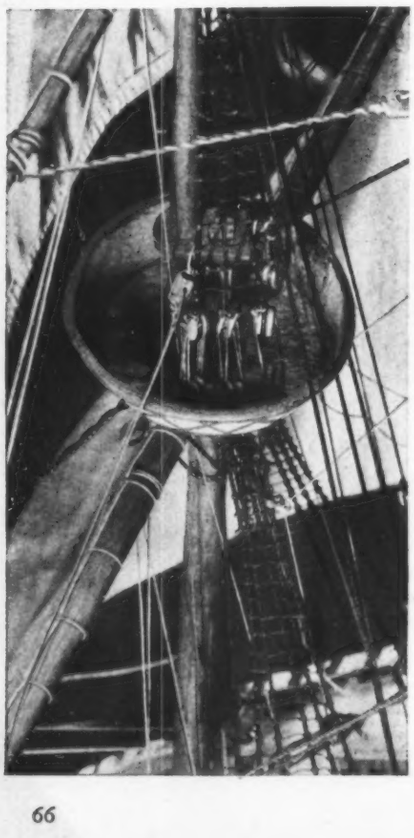


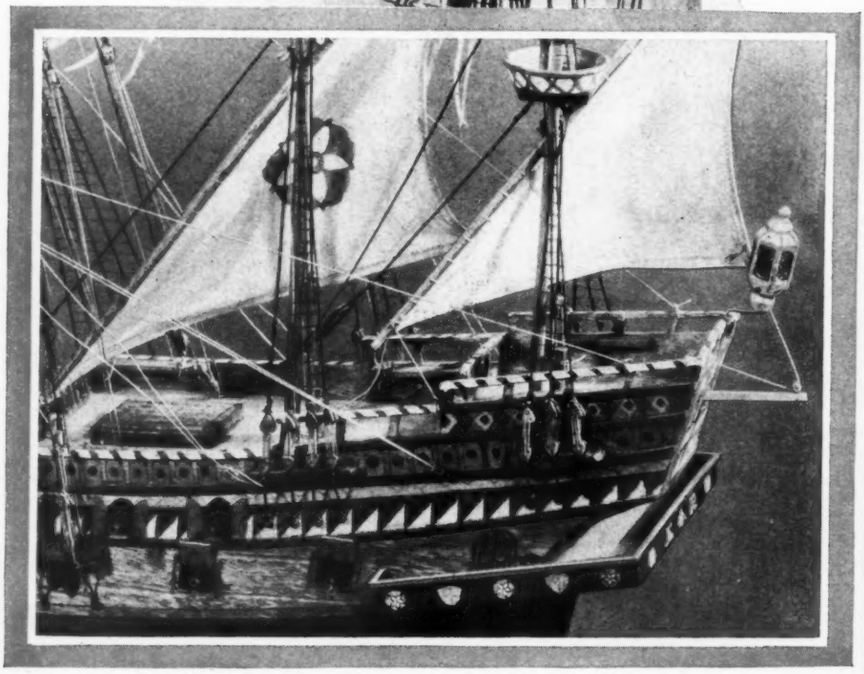
THOSE ship model builders who are constructing the Elizabethan galleon *Revenge* and have kept abreast of the work outlined in the three preceding articles (P.S.M., Apr. '33, p. 65, May p. 67, and June p. 66) are now ready to begin the rigging in earnest.

For the lower rigging, use ¼-in. heart-shaped deadeyes, and for the topmast 3/16-in. deadeyes. Round deadeyes might be used, but are not strictly correct. These and the blocks are best made from boxwood or other hardwood, but celluloid or other materials may be used. The deadeyes may be black, but I made mine brown and used brown lanyard of size *c* cord.

The simplest way to make heart-shaped deadeyes is to plane up a long strip of nonsplitting wood, such as boxwood, oblong in section, the edges being the thickness of the deadeyes and the width equal to their extreme length, as shown at *B* in the drawings on page 86. Score this long strip down the center of both edges to form grooves. Along the flat side, mark the shape of the deadeyes, one edge being the base and the other edge the apex, as illustrated. Drill the holes, then cut off the waste piece at one end with a fine saw. Now groove this slanting end with a file as shown at *C* and round the corners slightly. Cut off the first deadeye as at *D* and groove the one remaining edge; then slightly round off the faces and remaining corners as at *E*. Continue this way, one deadeye at a time.

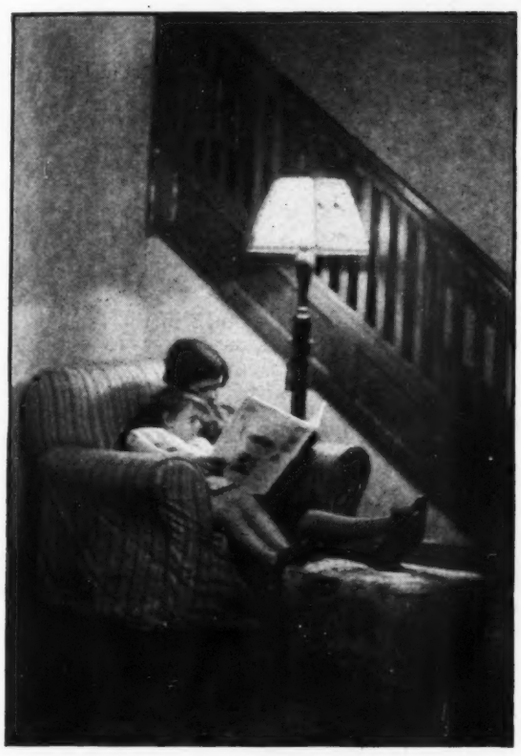
The deadeyes must now be fastened down to the channels. I did this with No. 20 copper wire by taking a turn around the deadeye and twisting it underneath as shown at *F*, then twisting an eye in the lower end, *(Continued on page 85)*





The mizzen and bonaventure shrouds and, above, the rigging of the fore-topmast and the topgallant mast

Left: **Looking down on a mast top. Compare this photograph with the drawing of a top given on page 86**

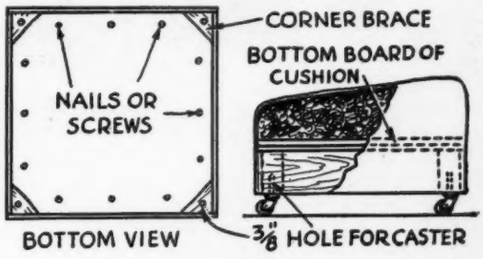


COMFORTABLE SLANT-TOP OTTOMAN MADE FROM OLD AUTO CUSHION

The auto cushion is merely mounted on a box fitted with casters, and the whole is covered with suitable upholstery cloth placed on box and cushion separately

THE ottoman illustrated was made in about an hour's time from a discarded front-seat cushion from a coach type auto. The slant makes it unusually comfortable.

A local grocery supplied a wood box of approximately the dimensions of the bottom of the cushion, and the two were nailed together as shown below, with the box set bottom up. A block of wood was nailed into each corner of the box and drilled to take a caster. The tapestry cloth covering was placed on box and cushion separately. The cushion cover was made large enough to envelop the whole and was fastened with thumb tacks to the box to facilitate removal for cleaning. If storage space is desired for magazines, sewing materials, or the like, the box can be used right side up and the cushion hinged to it. The cushion and box covers would have to be entirely separate in that case.—D. A. BUTLER.



INCENSE BURNER TURNED FROM WOOD

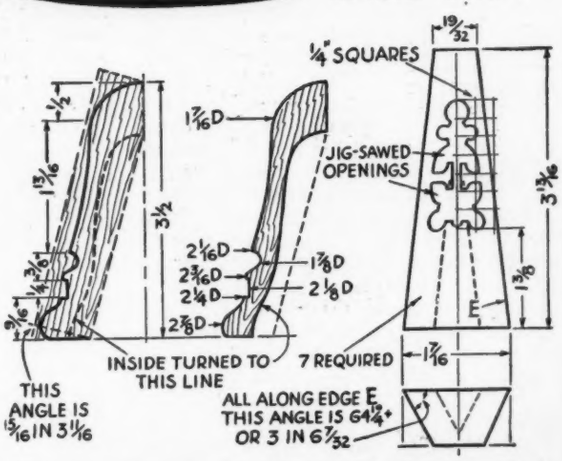
MADE of hardwood and finished either with paint or with stain and varnish, this incense burner is an attractive and easily constructed novelty for gift purposes.

Prepare seven wedges according to the dimensions given, trace on each the pierced design, drill, and jig-saw. A blade less than 1/16 in. wide should be used. With careful sawing, no other smoothing of the holes is needed. To cut the beveled edges, tilt the saw table to 64¼ deg. from the horizontal, or 25¾ deg. with the vertical. Verify the setting by cutting a test block and comparing it with a bevel set at an angle of 3 in. in 6 7/32 in. Use as wide a blade as possible to insure straight cutting. Straighten the edges with a plane or on a sanding disk.

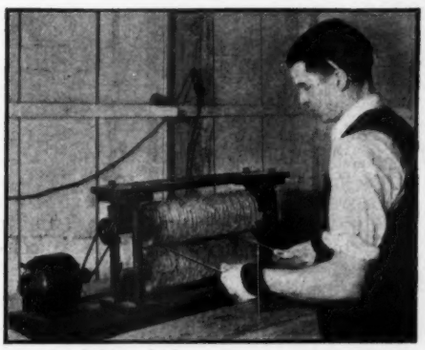
Casein glue is especially adapted to the gluing of this piece. Coat all mating surfaces and rub the pairs together individually, building up the mass a wedge at a time. When the assembly is complete, wind a few turns of flexible stranded wire around the center and force them downward to clamp the parts. Be sure the latter are in alignment, and glue the base temporarily to a piece of thin plywood.

When the glue is dry, trim the base block and mount it on a lathe faceplate. Turn at a fairly high rate of speed with light cuts, and sand thoroughly. Then split away the base block. Put a thick block on the faceplate and bore out a chuck into which the work can be forced for inside turning. A sharp ¼-in. chisel is useful in this operation.

Finish the burner as desired. If walnut or maple has been used, an attractive antique finish can be obtained by filling with a mixture of floor wax and rottenstone, well wiped off across the grain and picked out of the holes. To prevent marring the finished surfaces on which it may be placed for use, glue a ring of thin felt on the bottom. Use any suitable small receptacle to hold the burning incense inside the wood.—E. M. L.



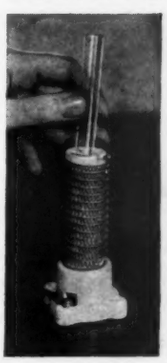
The segments are cut out, jig-sawed, then beveled on the edges and glued together, and the whole is turned to shape



WRINGER CLEANS GLASS

AN OLD laundry wringer can be put to profitable use to clean glass, metal, wood, and other flat materials, as shown in the accompanying photograph. The wringer is mounted solidly on the workbench. Strips of discarded canvas belting are cut up in small disks of uniform size and packed solidly on the two rollers. These serve as an excellent buffing material. A pulley attached to an extension on the top roller receives the power from a small electric motor. This simple device does excellent work.—J. K. NOVINS.

HEATER FOR TEST TUBES



REPLACEMENT units for use in electric heaters of the bowl or reflector type are wound on porcelain tubes and therefore make excellent slow heaters for chemical experiments. Most of them have an inside diameter large enough to take in the smaller test tubes. If enough time is given, a boiling temperature will be reached.—A. H.

Handy Hints *for* Motorists

Suggestions Valuable to All Car Drivers Are Contributed by Experienced Readers

By installing a lamp fixture on the front of the dashboard, as shown in the circle, a light is provided for your work as indicated above

ALTHOUGH a flashlight is a convenient accessory when making emergency motor repairs or checking the oil at night, it is generally not in the car when most needed. However, the amateur mechanic can provide a convenient motor light by installing an ordinary dashboard lamp fixture on the front surface of the dash or motor compartment cowl. The dashboard fixture should be of the older type having a built-in switch. These can be purchased cheaply from auto parts dealers or can be salvaged from old cars in an auto graveyard. The metal dash or cowl forms the ground and the second wire is connected to the ammeter. By removing the glare shield from the fixture you can fit it with a headlight bulb.—L. VAN T.

Reflects Traffic Light

OVERHEAD traffic lights, cut from view by the top of your car when you head the line at an intersection, can be made visible by a simple windshield reflector made from a block of wood and a highly polished, nickel-plated, steel furniture leg glide. As shown in the illustration, the glide or caster is driven into the top of a triangular block of wood. To avoid splitting the wood, it is best to drive the glide before cutting the block to shape. Glue the wood block close to the bottom edge of the windshield and in such a position that the dome-shaped surface of the glide is seen easily from the driver's seat. When properly placed, the curved glide will reflect the overhead lights.—L. C. P.

Drawing shows how caster is set to reflect overhead light

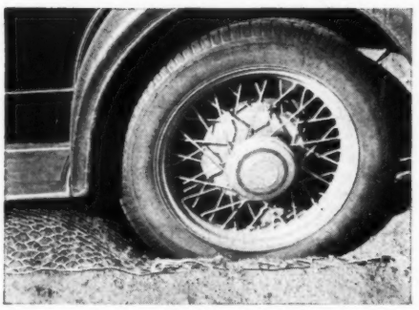
Speed Governor

PERMANENT harm can be done a new car by driving it at excessive speeds during the first 2,000 miles. A short length of one-half inch pipe can be made to serve as a simple speed governor during this period. The foot knob on the accelerator is first removed, the short pipe slipped over the rod, and the knob screwed back into place. The pipe or sleeve then prevents the accelerator from being pushed down below a certain point according to the maximum speed recommended. Cut the pipe approximately to length and then add thin washers to obtain the final speed adjustment. You can judge the approximate length of the pipe by pressing down the accelerator until the highest speed at which the new car should be driven is obtained. Then note the distance between the underside of the accelerator foot knob and the floor boards and cut the pipe to fit. This simple device also would prove of genuine use when the inexperienced person first starts driving as it would prevent sudden jerks.—F. X. P., Jr.

A piece of half-inch pipe, set beneath the accelerator, keeps car within permitted speed

Wire Netting for Sand

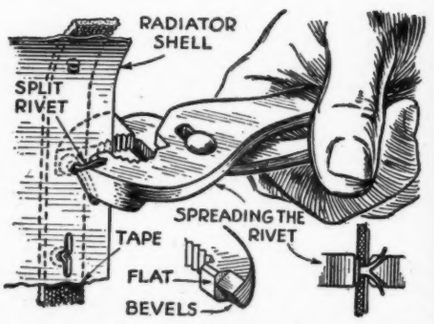
FOR the summer motorist who intends to travel off the paved highways at the seashore, a four-foot strip of chicken wire netting will prove a useful addition to the tool kit. If the car gets stuck in the sand, it is necessary only to slip the strip of netting under the wheel and apply the power. The wheel resting in the sand will climb right out of the hole without the usual spinning and strain on the drive shaft. The same strip of netting can be carried during the rest of the year for use in case the car gets stuck in the mud. Being flexible, the netting can be rolled into a small bundle and stored under the seat.—K. F.



Wire netting carried in tool box is helpful if used as shown, when car gets stuck in sand

Rivet Pliers

WHEN replacing small split rivets, it is often difficult to fasten them with ordinary tools. This is especially so when it is necessary to renew the rivets that hold the canvas lacing to the radiator shell and cowl of an automobile. By reshaping the tip of an inexpensive pair of slip joint pliers, however, you can make a special split rivet tool. On an emery wheel, regrind one jaw to a beveled point for a distance of ¼ in. back from the tip. Directly behind this angle, also slightly bevel the sharp edges of the flat jaw. The V-shaped tip is used for the splitting operation while the beveled flat portion at the rear serves for squeezing the rivet flat.—W. H. A.

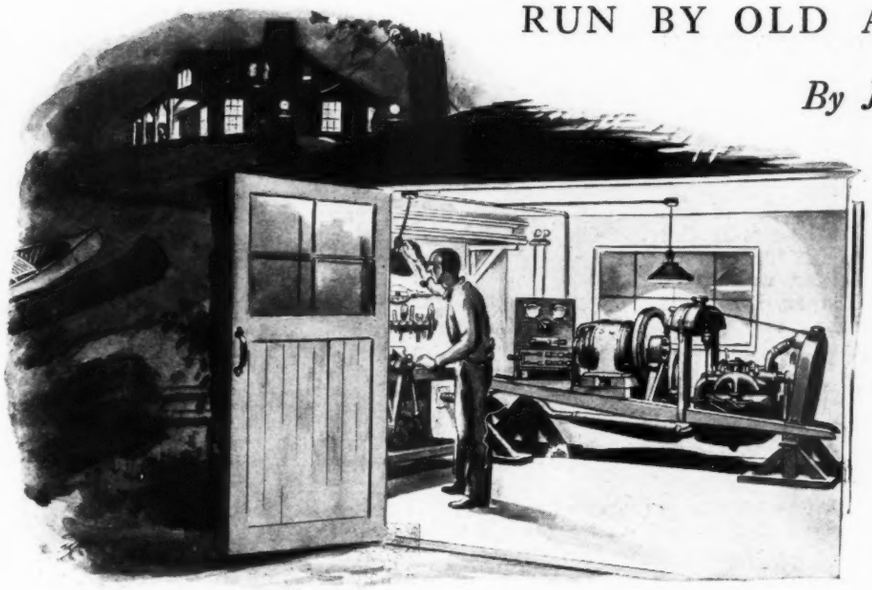


Drawing of slip joint pliers reshaped for use as a special split rivet tool for emergencies

Small Electric Power Plant

RUN BY OLD AUTO ENGINE

By J. L. Bird



This economical electric power plant won fourth prize in our recent Auto Engine Contest

MANY districts in our country are still without electric power facilities. It is quite easy and inexpensive to construct a dependable power plant by using an automobile engine for the motive power.

The chassis of a discarded or wrecked car, stripped of all equipment except the engine and radiator, serves as the mounting for the generating equipment. The drawing below shows a Ford "A" engine, but any other type will serve equally well.

Support the car frame on two wooden horses made as shown. To reduce vibration, build in rubber pads constructed of several layers of inner-tube rubber. The rear support should be higher than the front so that the generator shaft will be perfectly level. This will eliminate excessive armature end play.

Purchase from a dealer in used electrical equipment a good 5-K.W., 115-volt D.-C. compound-wound generator. A shunt machine will also serve, but the compound winding will give better voltage regulation on heavy loads. The cost of such a generator at second-hand value will be approximately $50.

The builder should also purchase an engine speed governor, such as that used on Fordson tractors, costing about $14.

On the rear of the engine-transmission housing, mount a drive pulley at least 10 in. in diameter.

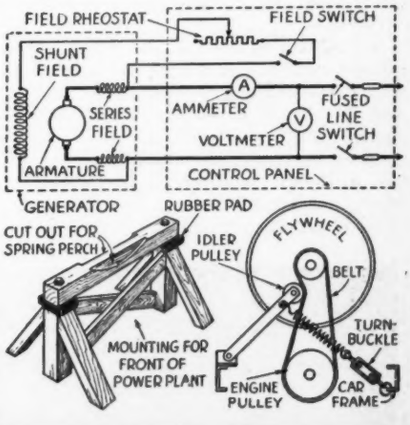
Support the generator on hardwood cross members as indicated. It is recommended that the generator be fitted with a flywheel, which will tend to maintain a more uniform generator speed when heavy electrical loads are suddenly applied or removed. An old automobile flywheel or the type used on cordwood saws will serve admirably for this purpose.

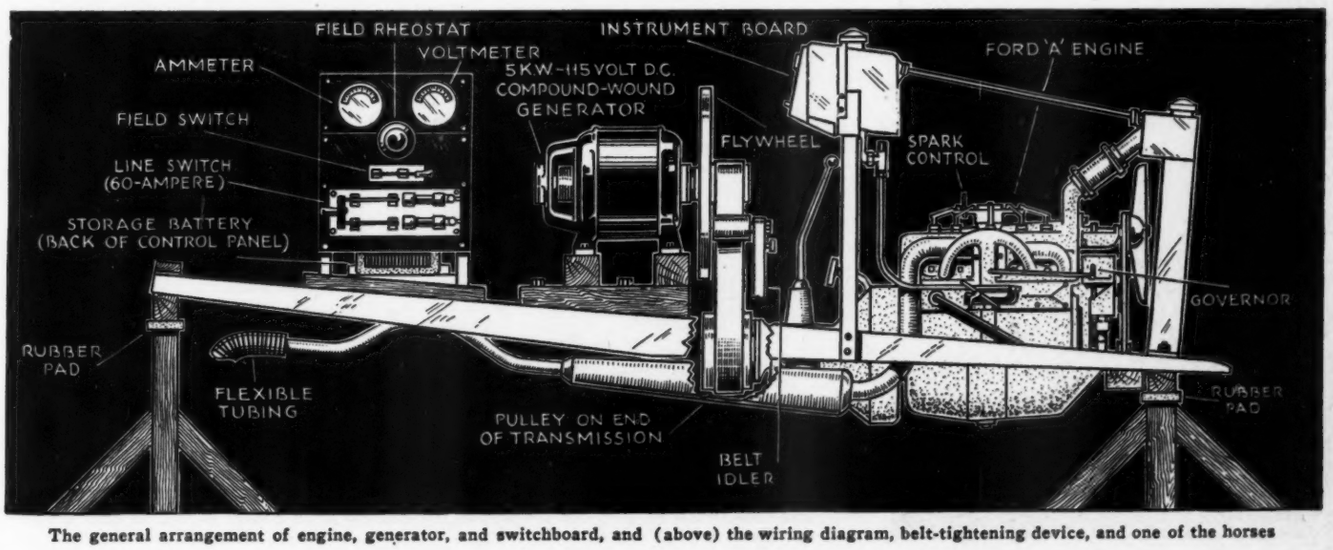
The generator's rated speed will probably be 1,800 R. P. M. The most economical engine speed is in the neighborhood of from 900 to 1,000 R. P. M. The generator belt pulley should, therefore, be approximately one half the diameter of the drive pulley. A belt-tightening device to maintain positive belt tension is easily constructed, as shown.

The regular car gas tank should be mounted on supports to use gravity feed for the gasoline. The instrument panel may be left intact in its original position.

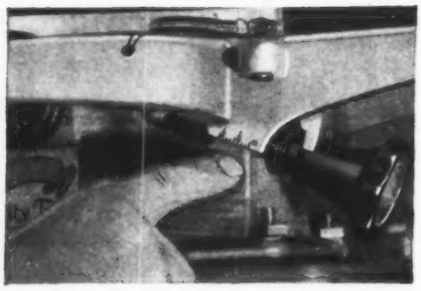
Engine controls may be left nearly unchanged. The gear shift lever should be bent forward to clear the generator. Spark control may be had by mounting a small lever on the engine head. The governor will operate the throttle. Electric starting may still be used and may even be arranged for remote control.

A control panel containing an ammeter, a voltmeter, field rheostat, field switch, and line switch is shown on the sketch. The meters are not absolutely essential, but serve to check output and voltage.





The general arrangement of engine, generator, and switchboard, and (above) the wiring diagram, belt-tightening device, and one of the horses



CALIBRATING A JOINTER

WHEN chamfering, cutting rabbets, or planing the edge of a piece of wood for part of the length, it is a great advantage to have some way of setting the knives of a small jointer to cut a shaving of definite thickness.

Set the table at zero by laying a block of wood over the knives and lowering it until the cutting edges, when turned by hand, just graze the wood. On both the stationary and the movable member of the base, make a pen mark across the inclined slide. Then lower the table until the knives cut ¼ in. deep, and on the table casting make a mark extending from the zero mark on the base. Divide this length in the middle, halve the resulting spaces, and halve them in turn. The short divisions represent cuts of 1/32 in.; and it is easy to estimate by eye the 1/64-in. positions between. When the knives are reground, relocate the zero mark.—E. L.

QUICKLY CONSTRUCTED BOAT TRAILER

A NEAT, serviceable, and inexpensive boat trailer may be made by mounting the chassis of a junked model-T Ford on the front axle and springs of an old Chevrolet and bolting on three bolsters of 2 by 6 in. wood. A T-shaped drawbar of 3-in. pipe is welded into the front and braced with two sections of 2 by ½ in. bar stock, as shown.

A section of garden hose is applied to the top of each bolster with nails. The heads of the nails are driven through the top layer of rubber and tightened against the inner surface of the hose. The 6-in. standards at the ends of the front and rear bolsters are wrapped with rubber, which is tacked on the outer side. Web straps are applied to the ends of the bolsters, to be buckled over the boat. The finest finish is not marred in transporting a boat with this trailer, which may be used for either speedsters or utility boats.—JOSEPH C. COYLE.

A boat trailer made from discarded automobile parts

LINOLEUM CUT WITH SAW

AFTER blistering my hands and making a botchy job of cutting linoleum with a knife to fit in recesses of the kitchen and around the gas and water pipes, I discovered that a small hand-type scroll saw is ideal for this purpose.—R. W. McP.

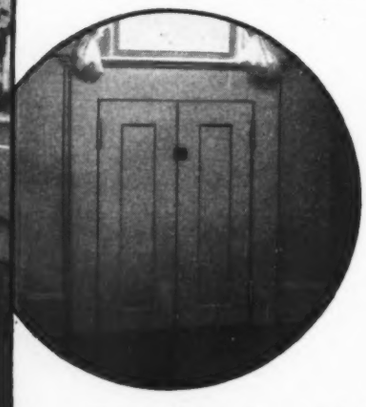
Compact Breakfast Nook Folds into Cupboard under Window

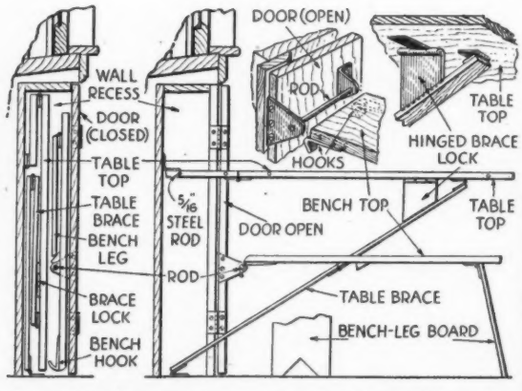
ALMOST like magic this entire dining alcove outfit, which includes a table and benches for five persons, can be unfolded out of the wall from a small cupboard under the window. The table, 27 in. wide and 50 in. long, is in two parts, supported by a brace. The brace is also in two parts, so arranged that the table can be folded or unfolded by a child.

When the table is extended, the supporting brace automatically locks so that it cannot collapse until released by hand. The lock is a triangular piece of heavy brass hinged under the table. It falls by gravity as the lower supporting brace comes out straight and prevents the brace from going back by accident. In folding the table, this triangular piece is pushed to one side while raising up the brace. The front of the table then drops partly down until the supporting brace strikes the table farther back, and the table then rides and makes the second fold automatically on the brace as it moves back into the wall. It happens to be so balanced that no real force is required to move it at any part of the operation. By this I mean that not over two or three pounds of force are required, yet the table, although of comparatively light construction, may weigh around twenty pounds with its various hinges and rods.

The table top is made of lumber a full inch thick when dressed. The boards are glued at the joints and are held together by four steel rods 5/16 in. in diameter. The heads and nuts are, of course, sunk in and plugged over. This makes the top look like one flat piece.

From the diagrams it will be seen that part of the table folds upwards and the main portion just fills the wall opening, which is 42 by 27½ in. The two benches then fold against the two doors on the inside so that, when the doors are closed, all parts are in that space and within a depth of only 5½ in. The advantage of this folding set is that it is easier to clean up when the table and benches are out of the way, and it gives extra room in the kitchen.—P. G. BERNHOLZ.



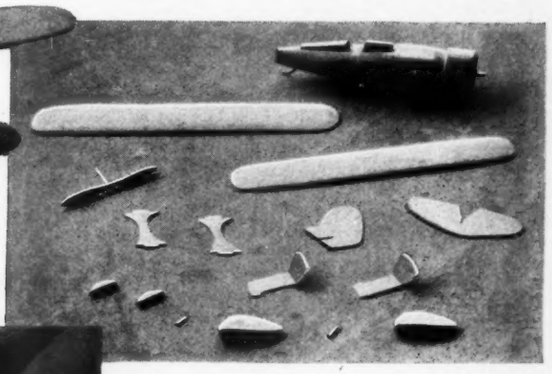


The breakfast nook open and closed, and drawings to show method of folding and how the bench tops slide behind the doors. The design may be modified to suit the space

A Racy Little Biplane

DONALD W. CLARK'S *latest model*

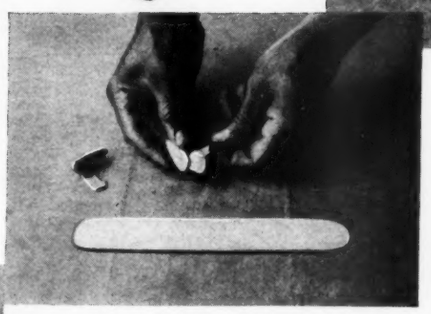
The scale of the model in comparison with the full size Laird plane is 3/8 in. equals 1 ft. The wing spread is 9 in. and the round fuselage is only 6 in. long

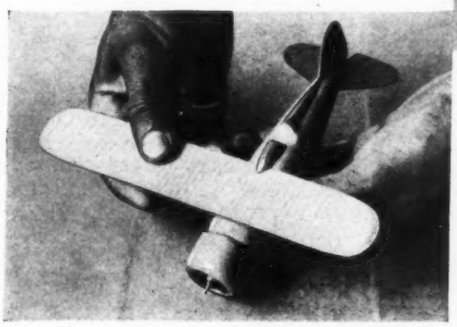


Only seventeen parts (not counting the motor) are needed. *At left:* Applying wheel "pants"

THIS neat little Laird Super-Solution plane will appeal to model builders who prefer making small, racy-looking biplane types.

The fuselage can be carved from a section of 1⅜ in. diameter curtain pole, 6 in. long. If no lathe is at hand, the front end can be shaped with knife, chisel, and sandpaper. Saw the tail slots before carving. Use a fine coping saw to cut the cockpit and the recesses for the upper and lower wings, which are to be fastened with small brads.





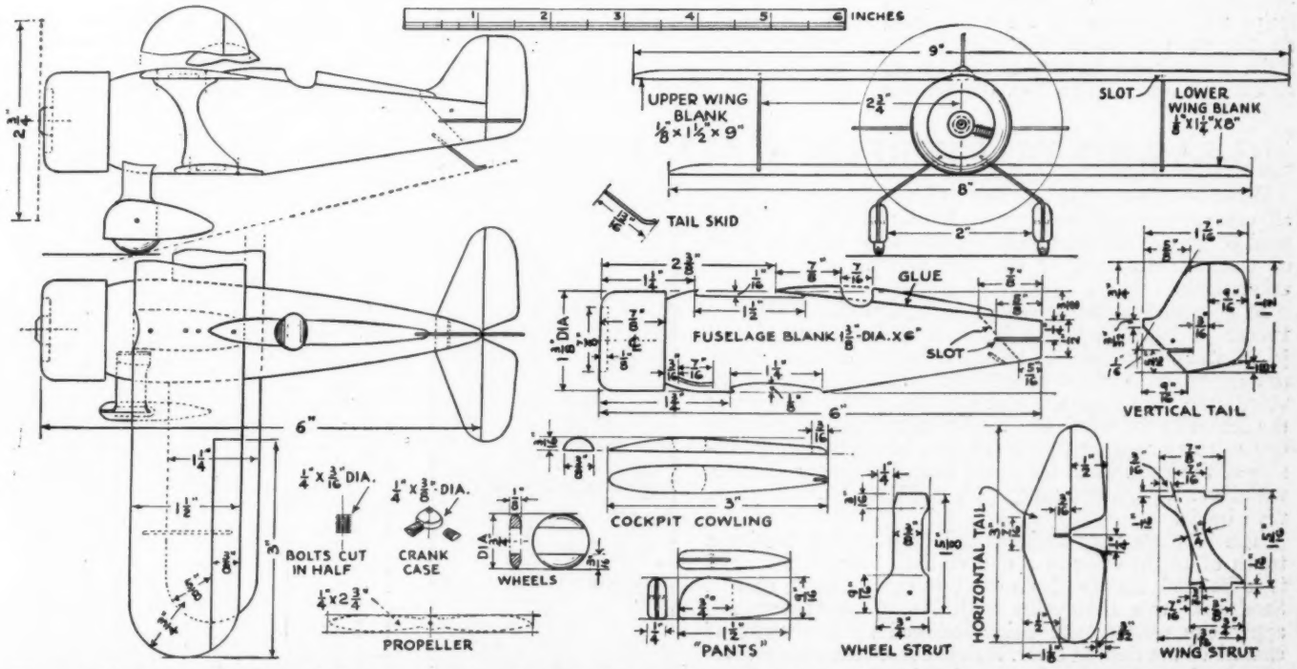
Sliding upper wing into position. The cockpit cowling is glued on the fuselage and notched out

The motor cylinders may easily be represented by using 3/16 in. diameter bolts. These must be divided in half lengthwise and also cut up into pieces ¼ in. long. Center the crank case in the recess in the front of the fuselage block, and cement or glue the cylinder pieces flat side in, to form the cylinder circle. You will not be able to get in more than six or seven cylinders (unless you use smaller bolts), but the effect is sufficiently realistic.

Cut the tail units from thin metal or 1/32-in. fiber. These are held in place with one brad in the vertical tail. Make the landing gear struts of 1/32-in. metal and bend as shown. These slip into slots in the "pants" and are held with brads, and their upper ends fit slots in the fuselage. Make the wheels of wood and glue them to the bottom of the "pants."

Cut the wings from pine, plane to shape, and finish with sandpaper. Make slots in the bottom of the upper wing and in the top of the lower wing to take the wing struts, which are made of thin metal or fiber. Cut the propeller from a metal blank ¼ by 2¾ in. and file to shape.

What special models would you like to have added to Mr. Clark's series?



The assembly views and drawings of all parts. Any dimensions not given can be estimated by referring to the scale. The model looks well if carefully painted in two colors, as follows: wings, wing struts, and horizontal tail, buff; fuselage, vertical tail, wheel "pants" and struts, pea green

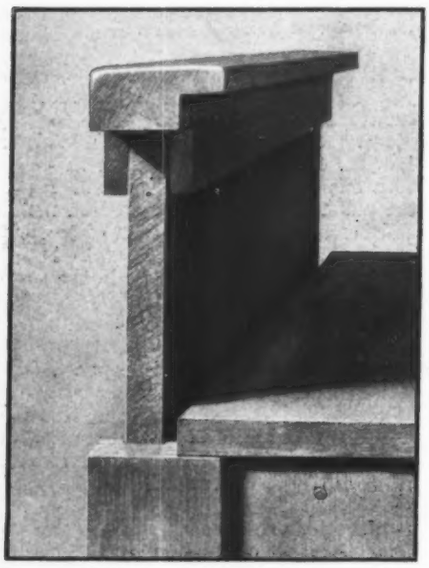
EASILY BUILT CABINETS EXCLUDE DUST

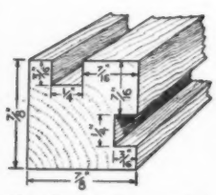
Two cabinets built for the special purpose of protecting fine tools, partly completed models, and delicate apparatus from dust in a basement shop

IN EVERY home workshop, especially if it happens to be located in the basement, there is a real need for a practical way to protect fine tools, partly completed models, and delicate apparatus from dust. The two cabinets shown at the right are designed for this purpose. They are easy to make and cost little for materials.

After you have decided what size cabinet will best suit your purpose, cut a base from a 1 or 1¼ in. thick board. Make the base about 2 in. bigger in both directions than the clearance you want inside the cabinet.

Now take a ⅞ in. thick board and rip off four square strips in length equal to the necessary clearance in height. Set up the dado head on your circular saw for a groove ¼ in. wide and 3/16 in. deep (or adjust a suitable hand plane for the same type of cut). Adjust the rip guide on the saw so that you can groove the square strips with one edge of the cut coming on the center line of that side of the strip. Cut rabbets on two adjacent faces of each square strip so that the grooves are each half the width of the strip from the corner between them as shown in the accompanying drawing.





Detail of corner post and, at left, the door slightly pulled up to show how joint along the top edge is fitted

Next set one of the rabbeted strips on the corner of the base with the grooved faces toward the adjacent corners and lightly trace the outline of the end of the strip on the baseboard. Repeat at the other three corners. Select a drill that will just give clearance to the shank of a No. 8 wood screw and drill down through the baseboard at the point within each outline where the hole will be well inside the pencil mark. Countersink the holes on the bottom of the baseboard and attach the upright.

Plywood panels, cut to fit in the grooves, form the four side walls of the cabinet. Now look at the large photograph again and note the small square pieces that are nailed in the corners of the joints between the side and back panels and the baseboard. Similar pieces cover the joints between the side walls and the plywood top.

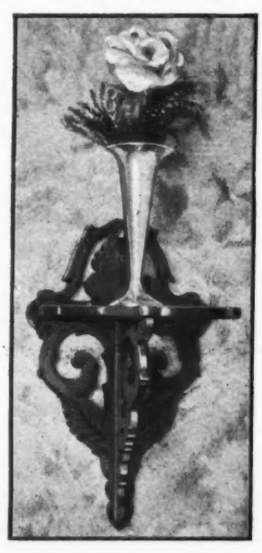
By studying the large illustration in connection with the other photograph, you will see more clearly how the dust excluding front slide is made.—A.P.L.

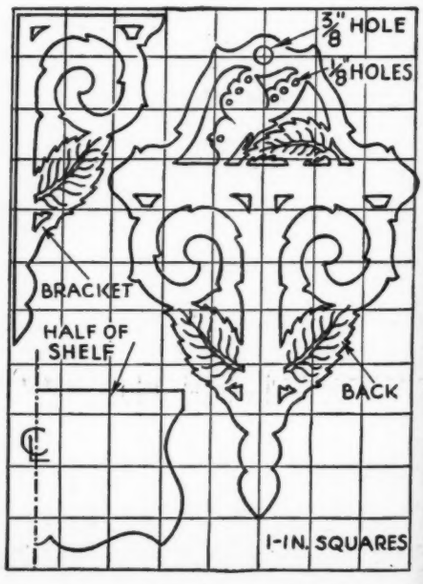
JIG-SAWED BUTTERFLY WALL BRACKETS

WELL-DESIGNED wall brackets relieve the bare look of an otherwise empty wall space. A pair of them may be used to special advantage on opposite sides of a fireplace or entrance archway, or on each side of an alcove or other nook.

A jig-sawed butterfly design is illustrated. Three-ply veneer ¼ by 10½ by 13 in. or a similar piece of any ¼ in. thick wood will be sufficient for one bracket. Copy the design on a sheet of cardboard which has been divided into 1-in. squares. Cut out the pattern and trace the design on the wood. Cut the bracket with a hand coping or fret saw or on a power scroll saw, keeping slightly outside of the lines. Then file to the lines. Sandpaper all parts with Nos. 1, ½, and 0 sandpaper, and assemble with ½-in. wire brads.

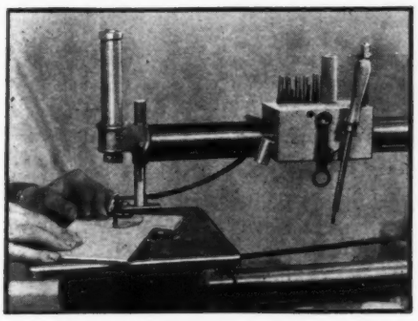
The brackets may be lacquered or enameled to give a touch of bright color in a dull or dark room. If enamel is to be used, first brush on one thin coat of white shellac. Sandpaper this thoroughly with No. 0 sandpaper, and apply one coat of flat paint followed by two coats of enamel of the desired color. Rub the last coat with pumice stone and water. For a lacquered finish, two coats of lacquer will be sufficient.—ANTHONY T. PUSCIZNA.





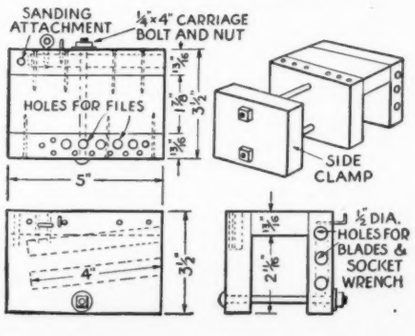
LIGHTED SCREW DRIVER FOR USE IN DARK

A CHEAP fountain pen flash light and two rubber bands are all that are required to make it easy to drive or remove screws in dark corners where the slots in the heads cannot otherwise be seen. Place the barrel of the flash light on the shank of the screw driver and hold it with the rubber bands as shown above. Then snap the button in the end of the flash light and see what a great aid this will be when working in places that are badly lighted.—GEORGE E. KILPATRICK, JR.



CONVENIENT TOOL RACK CLAMPS ON JIG SAW

FROM scraps of wood, a convenient jig-saw tool rack can be made. Build an inverted "U" of a width suitable for straddling the frame of the saw, if it is not of the rocker arm type, or make it of any convenient dimensions for clamping at the side. The rack shown above was drilled in the upper edge of one side to hold files, while ½-in. holes were made in the end of the other side, sloping down, for blades and a wrench.—E.L.



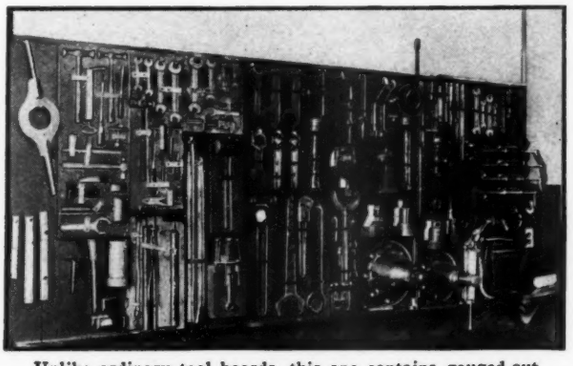
VISE JAWS LINED TO AID IN SOLDERING

WHENEVER it is necessary to hold parts made of light metal in a vise to be soldered, the jaws conduct the heat away so rapidly that the solder tends to "freeze" before penetrating far enough into the joint to make a good job. A simple way of getting around this trouble is to obtain two squares of sheet asbestos packing at least 1/16 in. thick and as wide as the vise jaws, and bend them L-shaped with the short leg as long as the depth of the jaw face. Scrap pieces of asbestos packing or gasket material can be had for little or nothing at any steam fitter's or plumbing shop.

These jaw liners are dropped into place before putting the work into the vise, and are so effective in conserving heat that the joints may readily be sweated together with their aid in cases when it would otherwise be necessary to use a blowtorch. The asbestos is also yielding enough to reduce the likelihood of distorting or marring the parts with the vise jaws. It serves the same purpose, indeed, as if special soft metal jaws were used, besides conserving the heat.—ELTON STERRETT.

Asbestos liners, bent L-shaped, are placed over the vise jaws to prevent the heat from being carried away

RECESSED PANELS KEEP TOOLS ORDERLY



Unlike ordinary tool boards, this one contains gouged-out recesses for the tools so that they cannot be misplaced

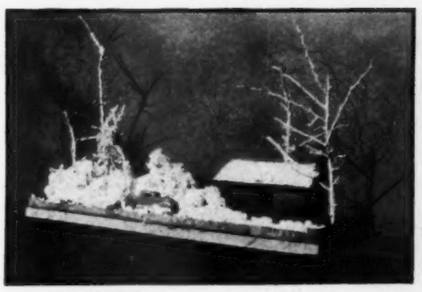
PANEL tool boards for the wall of a shop with the outlines of the tools painted on them are well known, but they have one drawback. The wrong tool may be placed in a certain spot, regardless of the outline on the board. This is impossible on the board illustrated because each tool is inset in a closely fitting recess and most of them go in flush with the surface.

The board consists of two 4 by 6 ft. sections, each with a 1 in. projecting border. On this board are fastened, with wood screws, panels from 1 to 3 in. thick, on which the outlines of the tools have been marked and chiseled out. To aid the eye in quickly placing tools, the background of each niche is painted white. Panels are added to the board as tools accumulate. This is a most flexible method, since the individual panels may be shifted if necessary.—J. C. C.

A QUICK GROWING DEPRESSION GARDEN

VARIOUS mixtures are used in making so-called "depression" gardens of the type illustrated, but I have found the following more effective than salt and bluing alone or other combinations: 4 tablespoons of salt and 2 tablespoons each of air-slaked lime, cornstarch, and bluing. Mix the three dry materials, then add the bluing and enough water to give a liquid mixture. This alone will "grow" into a beautiful snow effect, but a little fruit coloring can be added where desired.

The garden shown was made in a tin tray 1 ft. wide, 2 ft. long, and 1 in. deep. Plain ashes and a few small clinkers gave the hilly effect, and a few bare branches and cedar limbs were stuck into the ashes after being dipped into the solution. The house was built from scraps and the roof covered liberally with the liquid. The fence was made from a strip of ½-in. hardware mesh. The little automobile is a toy.—CARL G. ERICH.

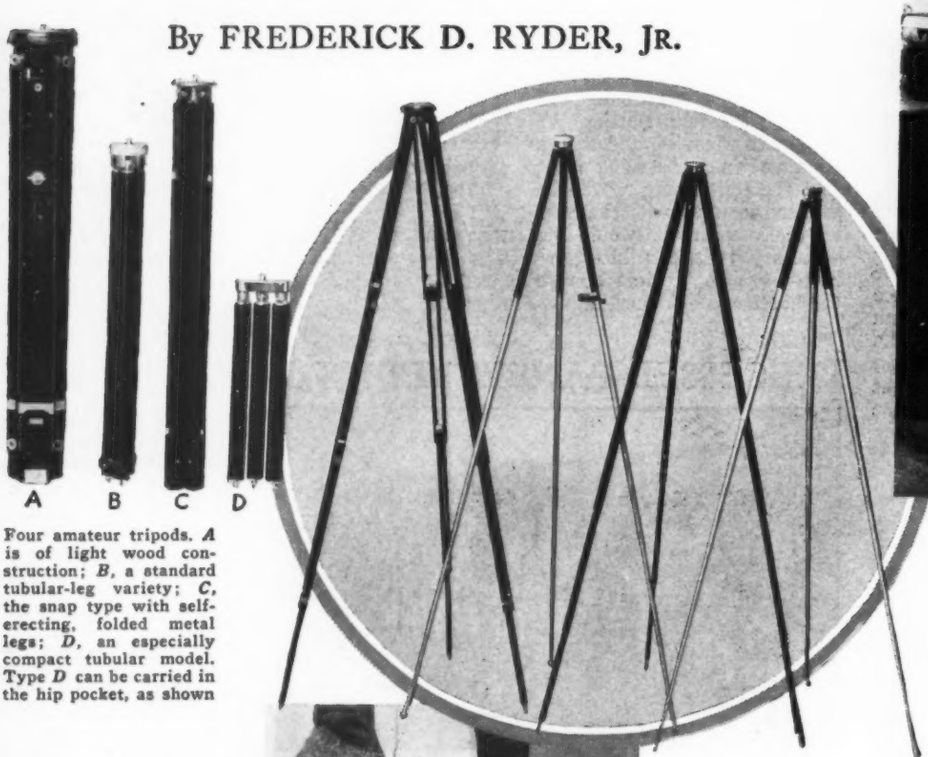


This realistic snow scene was "grown" with salt, air-slaked lime, cornstarch, and bluing

What the amateur photographer needs to know about

Camera Tripods *and* Supports

By FREDERICK D. RYDER, JR.



Four amateur tripods. *A* is of light wood construction; *B*, a standard tubular-leg variety; *C*, the snap type with self-erecting, folded metal legs; *D*, an especially compact tubular model. Type *D* can be carried in the hip pocket, as shown

You can gain a couple of feet on interior shots by folding one leg of your tripod and backing it against the wall

IF YOU were made of cast iron and had a clamp at every joint, you could stick out your arm, with your camera pointing in the right direction, tighten a few thumbscrews, and take fine time exposures.

Actually, when we try to stand perfectly still, our bodies sway back and forth, our arms wabble, and our hands tremble. That's why a commonly accepted rule is never to make a slower exposure with a hand-held camera than about a twenty-fifth of a second. Provided you hold reasonably still and don't give a sudden jerk just as you press the button, the camera won't be swayed enough during a twenty-fifth of a second to make the picture appreciably fuzzy.

Of course, there are people with such steady nerves and muscles that they can get away with tenth- or even fifth-second exposures when conditions are favorable (firm ground on which to stand and no wind blowing).

No matter what kind of camera you have or how fast the lens may be, you need some sort of firm support to get good results from many of the pictures you will want to take. Interiors, outdoor shots in poor light, camp scenes in heavy woods, and so on, all call for relatively long exposures. Even when it is technically possible to take a snapshot, better results usually can be obtained by using a smaller lens opening and a longer exposure.

Choosing a suitable tripod or other portable support depends both on the size and weight of your camera and your own personal ideas as to how much extra weight and bulk you are willing to carry in order to be prepared for all picture possibilities.

The strength, rigidity, and durability of a tripod, if it is properly designed, are roughly in proportion to its weight and bulk when folded. Other factors of importance are the height when fully extended and whether or not there is any provision for adjusting the height.

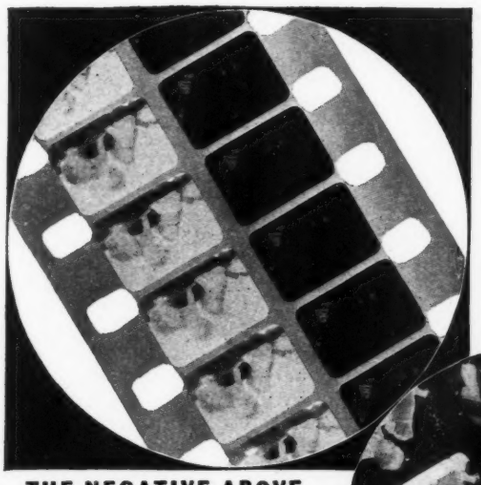
Four typical amateur tripods are shown ready for use and folded for carrying. *A* is about the lightest construction possible in wood. Only the end section is adjustable for length. *B* is a popular tubular-steel tripod that will support the camera at various heights from the ground, depending on how many sections of the legs are pulled out. *C* is a snap type, the legs automatically unfolding, section by section, when a release is pressed. The legs are of U-shaped or channel section. It has no swivel top nor can the length of the legs be changed. *D* is a tubular brass leg tripod designed for extreme portability. It can be carried in its leather case in the hip pocket as shown in one of the photographs. In the same view a type *B* tripod is shown being carried by hand.

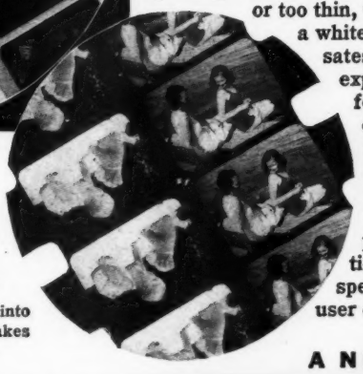
Types *B* and *D*, being made in the same way, afford an interesting comparison. Type *D* is extremely compact, but is not nearly so rigid in use nor so strong and durable as type *B*.

It would obviously be foolish to expect the hip tripod to give satisfactory service with a 3¼ by 4¼-in. or larger camera. It is suitable for use only with little cameras of 2¼ by 3¼-in. size or smaller.

No matter which type of tripod you buy, remember that it is designed for use as a camera *(Continued on page 79)*

Electric Eye Sees and Corrects Movie Mistakes!





THE NEGATIVE ABOVE

A magnified view of Ciné-Kodak Eight Film; an over-dense scene on one half and an over-thin scene on the other. It's up to the electric eye to spot this difference, to adjust the re-exposure accordingly.

AT RIGHT—THE RESULT

Both scenes have been saved, and made into equally clear positives. The exposure mistakes have been automatically compensated for.

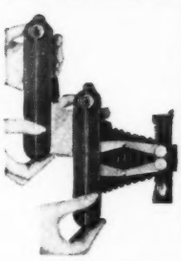
The movie film you send to an Eastman station for finishing is first developed as an ordinary negative and then changed to a positive. During the process, an electric eye scans every inch of the film for exposure errors. And for Ciné-Kodak Eight Film, with its double row of images, there are two eyes—one watching each row.

Just before the film is reversed from a negative to a positive, a pencil of red light plays on each tiny image. Sensitive thermopiles measure the amount of red light passing through the film. If they find the images too dense or too thin, they automatically brighten or dim a white re-exposure light, which compensates for the misjudgment in camera exposure. This exclusive Eastman feature saves many an under- or overexposed scene and gives you finished movies of uniform quality on the screen. It offers a much wider latitude of light conditions under which you can make good pictures. Eastman finishing stations all over the world provide this special processing service for every user of Ciné-Kodak Film.

TAKE IT ALONG

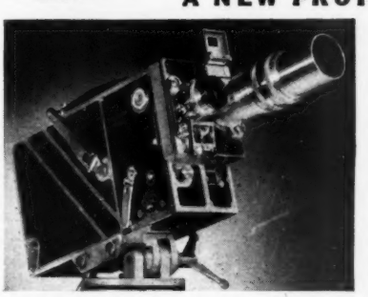
Ciné-Kodak Eight doesn't take up much space—yet it's a full-fledged movie camera. It gives you the low-down on your golfing form—takes clear, sparkling movies of your outings. A $2.25 film makes 20 to 30 scenes—less than 10c a shot. And the camera costs only $29.50.

OPENS LIKE A JACK-IN-THE-BOX



Jiffy Kodak, simplest folding camera ever devised, fulfills the need for a quick-action camera of keen picture-making ability. Touch a button—POP—it opens. Touch another—CLICK—it snaps the picture. Its smart appearance makes you proud to carry it. The quality of its pictures makes you proud to show them. Jiffy Kodak Six-16 (2½ x 4¼), $7.50. Jiffy-Kodak Six-20 (2¼ x 3¼), $6.75.

A NEW PROFESSIONAL-TYPE CINÉ-KODAK



Ciné-Kodak Special is a real professional-type 16-mm. movie camera. Precision-made, custom-built, a camera of unparalleled ability. It puts many of the tricks and effects of Hollywood within the advanced amateur's reach. It simplifies slow-motion analyses and other industrial studies. Double exposure — slow motion — dissolves — fades—variable shutter—masks—interchangeable film chambers—reflex finder focusing—variable speed—spring motor drive or hand crank—double lens turret. Write for Ciné-Kodak Special Book for complete, comprehensive facts.

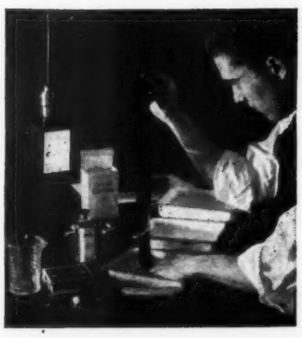
THE ULTRA-FAST FILM PROFESSIONALS USE

Now available in ROLLS and PACKS

Your present camera is a more versatile camera when loaded with the new Kodak Super Sensitive Panchromatic Film. This remarkable film is 50% faster than Verichrome in morning and afternoon light...three times as fast by artificial light. Its speed makes indoor snapshots at night possible with simple lighting equipment. Its keen panchromatic qualities add new beauty, richer detail to your prints. This new film is easily identified by the green lightning streaks on the box. It comes in both rolls and film packs in the ordinary camera sizes. Ask your Kodak dealer for it.

WATCH 'EM COME OUT

Have you ever finished your own snapshots? It's a fascinating hobby. Kodak Darkroom Outfit No. 1 contains everything you need for fast, easy developing and printing. Includes safelight lamp, three enameled trays, developing and fixing chemicals, 8-ounce graduate, stirring rod, thermometer, developing clips, auto-mask printing frame, and complete instructions. May be used in any room which can be darkened. Cost, only $8.75.



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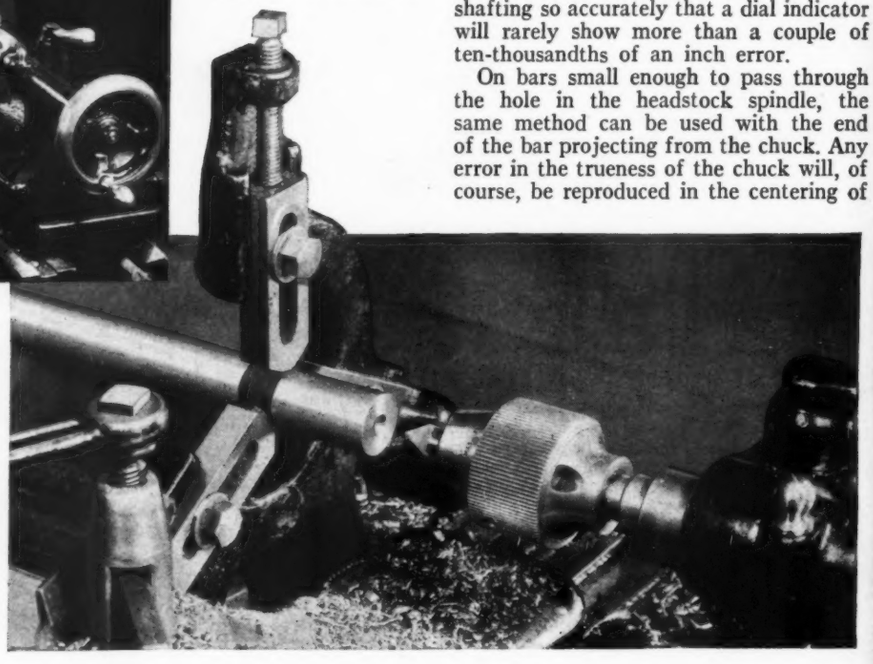
Centering Long Bars

IN THE LATHE

By

Thomas W. *Arnold*

Long bars can be centered with a high degree of accuracy if you know how to use the steady rest to best advantage. Once it has been set properly, a true center bearing can be cut in the end of the bar with a half-round 60-deg. centering tool. The photograph below shows the center hole after the centering tool is backed out



IT HAS been said that accurate centering is half the job in all lathe work. This applies with special force to the turning or threading of long bars.

Suppose, for example, the piece you need for the machine you are building must be over 1½ ft. long, with 6 in. or more of one end threaded and 2 in. of the other end turned down to a smaller diameter. Assume that the diameter is to be ⅞ in. and that the bar is to be a rotating part and therefore must run true.

An amateur would be likely to use 1-in. cold-rolled shafting. He would mark the centers with dividers or in some other customary way, centerpunch them, and use a combination drill and centering tool to drill them. A much more accurate way is shown in the accompanying photographs.

First, clamp the end of the bar in the universal chuck with which most of the lathes used by amateurs are fitted. Then place the steady rest in position so that its jaws come close to the end of the bar. Now raise the two lower jaws of the rest till they touch the bar. Rotate the lathe spindle by hand and see if the bar has a tendency to whip up off the steady-rest jaws. If the bar is reasonably straight and the chuck is fairly true, it will not. If it does, drop the upper jaw into contact with the bar.

Next, move a facing tool in the tool post so that its point just touches the end of the bar at what appears to be its center when it is revolving slowly. This will cause a tiny circle to be scratched around the true center of the bar.

Back off the upper steady-rest jaw, push the tailstock dead center up till it nearly touches the bar, and adjust the lower steady-rest jaws till the center of the tiny circle is squarely in line with the point of the dead center. Now set the upper steady-rest jaw firmly, but not too tightly, against the bar.

Apply a bit of lubricant to the steady-rest jaws—graphite grease is excellent for this purpose—and you are ready to face the end of the bar with the facing tool and then bore a 60 deg. angle center hole with a half-round 60-deg. centering tool. This is much more accurate than using an ordinary combination drill and centering tool. Feed very slowly, and if there is the slightest tendency to wabble, turn the flat of the point to a different position and repeat till you find a setting where the point will have no sidewise motion whatever as it bores its way into the end of the long bar.

After the angular bearing surface has been bored sufficiently large—plenty of bearing surface on the centers is desirable—back off the centering tool and replace it with a small twist drill. Feed this in till you have a hole about ⅛ in. deep at the bottom of the V-shaped depression made by the centering tool. This will provide clearance for the point of the center and also serve as a reservoir for lubricant.

This method, if carefully carried out, will center a good piece of cold-rolled shafting so accurately that a dial indicator will rarely show more than a couple of ten-thousandths of an inch error.

On bars small enough to pass through the hole in the headstock spindle, the same method can be used with the end of the bar projecting from the chuck. Any error in the trueness of the chuck will, of course, be reproduced in the centering of the bar, and as few universal or scroll type chucks are absolutely true, the steady-rest method is best if you want really accurate centers.

In an article to follow, Mr. Arnold will show how to overcome the baffling and unusual problems encountered in turning and screw-cutting long bars.

BATTLESHIP LINOLEUM POLISHES METAL

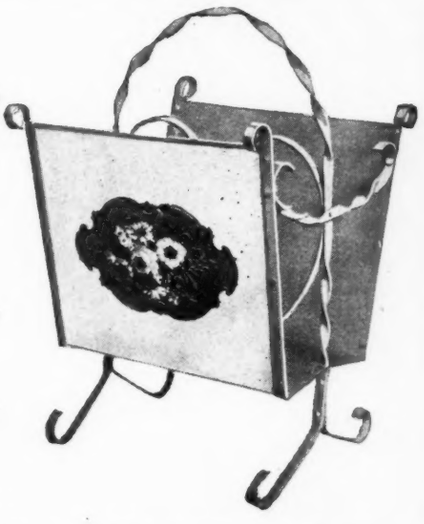
A SCRAP of old battleship linoleum makes a fast cutting and excellent polishing disk. I discovered this when I made a linoleum block cut recently for printing rifle targets. I turned out the rings and the bull's-eye on a lathe and was surprised to find that the linoleum cut high-speed steel nearly as fast as an emery wheel and left a beautiful polish. No scratches were visible to the naked eye.—M. A. C.

DURABLE

Magazine Rack

MADE FROM METAL AT LOW COST

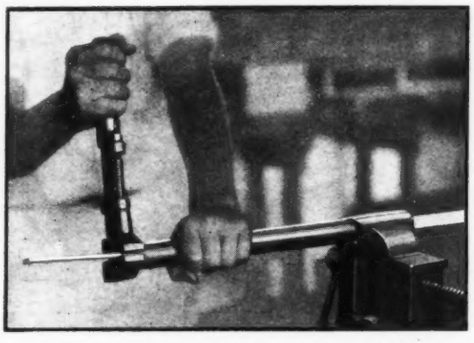
By Lee M. Klinefelter



The completed magazine rack. A transfer decoration on each side adds to its beauty

THIS magazine rack is roomy, durable, and good-looking, does not spill magazines all over the floor, and, best of all, can be made at little cost with the tools found in the average home shop.

The frame requires about 20 ft. of ½ by ⅛ in. soft steel. All the bends and twists are made cold, the twists being made before the bends. The twisting is done by clamping one end of the steel in the vise and twisting with a wrench at the other end. If a piece of ½-in. pipe of the proper length is slipped over the the steel before twisting, as shown in the photograph below, all danger of kinking the twisted parts will be eliminated. The sharp bends are made with a hammer over the edge of the vise, and the curves are bent over a piece of pipe clamped in the vise.

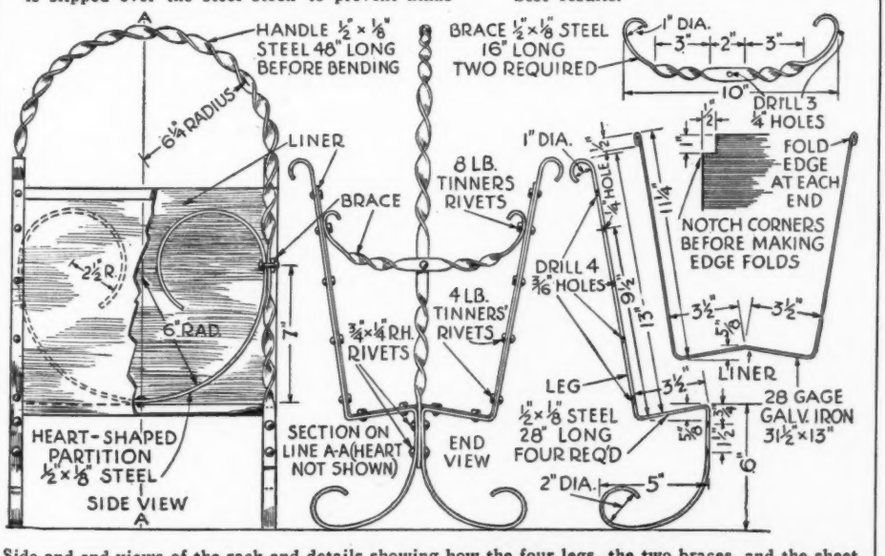


While the twists are being made, a length of pipe is slipped over the steel stock to prevent kinks

The galvanized iron liner may be bent by clamping the metal between two boards at the bending line and bending it over with the edge of another board. Care should be be taken to avoid hammer marks. If desired, you may have the liner bent up on a brake by the tinner or sheet metal worker from whom you buy the material. This will save time, insure smooth bends, and add but little to the cost.

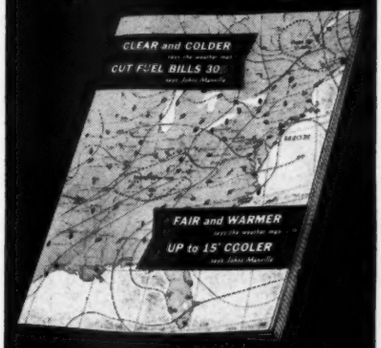
The location of the rivet holes and other details are shown in the drawings. Drill 3/16-in. holes for the 4-lb. tinners' rivets and ¼-in. holes for the 8-lb. rivets. A separate detail of the handle has not been given as its exact shape is shown on the side assembly view. Its lower ends are riveted firmly between the legs with two rivets at each end, as made clear in the end view.

Any harmonious color combination may be used in finishing the rack. Quick drying enamel looks and wears well. The use of transfer decorations on the sides will add much to the attractiveness of the finished piece. They may be obtained from paint dealers and art supply houses at small cost. Since the method of application varies, directions printed on the back of the transfers should be followed for best results.



Side and end views of the rack and details showing how the four legs, the two braces, and the sheet metal liner are bent. The handle can be laid out without difficulty from the two assembly views

Bedrooms too *hot* for sleep?



Send for this FREE booklet

Maybe you have wondered—

Why your house becomes so unbearably hot these summer days—and why that stifling heat lingers in your bedrooms all night.

Why, in winter, some rooms are practically impossible to heat, even with the furnace going full blast—

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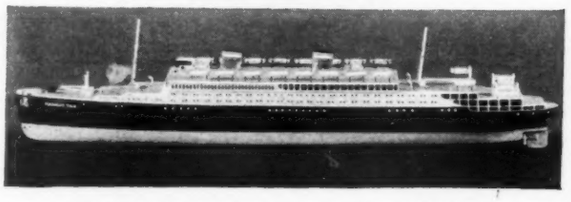


KIT F—Materials for 12-in. model of *Manhattan*

A CAREFULLY selected, timesaving kit of raw materials for building a picturesque model of the famous Elizabethan galleon *Revenge* is the latest addition to the construction kits offered by the Popular Science Homecraft Guild.

The new kit, marked *G* in the list below, contains a plywood centerboard sawed to shape and two plain white pine side blocks for making the hull, all the necessary thin plywood, chair caning spline, hardwood for small fittings, celluloid, dowels, wire, rigging cord, sailcloth, silk, beads, brads, pins, escutcheon pins—in fact everything but glue and paints. If, in addition, you wish the two main side blocks of the hull shaped and finished, order the kit marked *GG*.

The other kits available are also shown in the following list. Each is accompanied by instructions or blueprints.

A. Whaling ship model *Wanderer*. All the raw materials—wood, wire, fishing line, chain, celluloid, and everything but the paints, together with Blueprints Nos. 151, 152, 153, and 154. The hull is 20½ in. long....$6.90

AA. Same with hull lifts sawed.... 7.40

D. Spanish galleon ship model, 24 in. long. All the raw materials (except paints), Blueprints Nos. 46 and 47, and a booklet.... 6.45

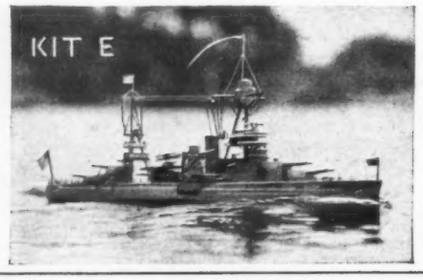
DD. Same with hull blocks shaped.. 6.95

E. Battleship model, U. S. S. *Texas*, 3 ft. long. All the raw materials (except paints) and Blueprints Nos. 197 to 200..... 6.95

EE. Same with hull lifts sawed.... 7.45

F. Liner *Manhattan*. All raw materials (except paints) for a simplified miniature model 12 in. long, and Blueprint No. 204.. 1.00

G. Elizabethan galleon *Revenge*. All raw materials (except paints) for a model 25 in. long, and Blueprints Nos. 206 to 209.. 6.75



GG. Same with hull blocks shaped.. 7.25

No. 2. Solid mahogany tray-top table 23 in. high with a 15 in. diameter top. Ready to assemble..... 5.90

No. 3. Tilt-top coffee table in selected maple with top 19 by 28 in., and 21 in. high. Ready to assemble..... 7.15

No. 4. Solid mahogany book trough 22½ in. long, 9½ in. wide, and 24¾ in. high over all. Ready to assemble..... 5.30

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381 Fourth Avenue, New York, N. Y.

Please send me Kit..... for which I inclose $..... (or send C. O. D. ☐)

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Note: Prices of all kits except *F* are 50 cents higher west of the Mississippi River because of heavy shipping charges. We prepay the postage on both cash orders and C. O. D. orders, but if you order C. O. D. you will have to pay on delivery the extra charges made by the Post Office, which amount to 28 cents. Kit *F* cannot be sent C.O.D. This offer is made only to readers in the United States.

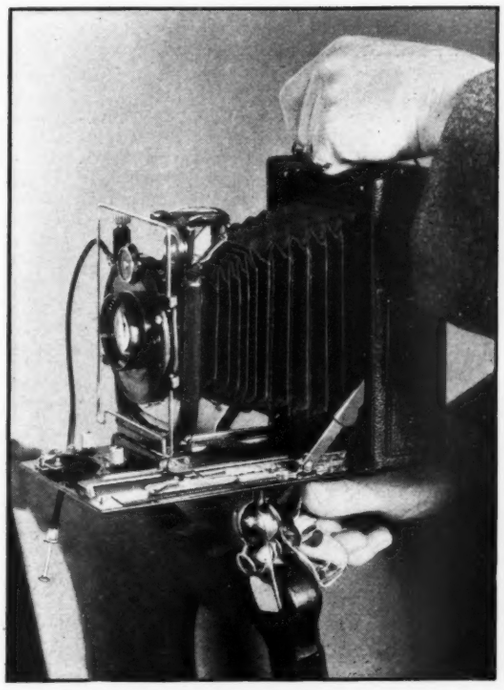
CAMERA TRIPODS AND SUPPORTS

(Continued from page 74)

support and should not be considered a substitute for a crowbar, hammer, or other apparatus on auto or camping trips.

Tripods have three legs so they will hold the camera firmly in a level position even on rough ground. By changing the position of the legs, it is possible to point the camera slightly upward or downward. Often, however, you will want to point the lens down or up more than the leg movement will permit. This is especially true of the home workshop enthusiast who wishes to take details from various angles of the things he has built.

For such work you need an accessory known as a tiptop. The photograph at the end of this article shows three types. *A* is a conventional ball and socket tiptop suitable for use with light cameras. *B* is a swing-table type that is stronger, costs more, and can be used with cameras up to the 4 by 5-in. size. *C* is especially useful. It is built heavier than *A* and, in addition, the lower portion is arranged in such a way that the unit will clamp the camera in any desired position to any suitably placed flat projection. It completely eliminates the need for a tripod in many cases. The photograph at the right shows an amateur camera being clamped with the aid of this device.



Taking an interior view with the camera fastened to a chair by means of the tiptop shown at *C* below

Tiptop *D* is a special type of camera clamp with a screw on a ball socket mounted on a pair of powerful, spring-operated, toothed jaws. It is especially useful on camping trips. It will hold firmly to the bark of a tree and gets a bulldog grip on any convenient branch or tent pole. If you do not wish to burden yourself with a tripod, then tiptop *C*, plus a chair, will support the camera for home interiors, and *D* certainly should be a part of your camp and outing equipment.

Do not assume, because you have placed your camera on a tripod, that pictures showing the fuzziness of motion are not possible. No matter how firm the tripod may be, remember that it has only three slender legs and that the camera will have a tendency to swing back and forth like a pendulum each time you jar it, in setting the shutter, for example. This is particularly true when the camera is on a tiptop and is considerably out of balance.

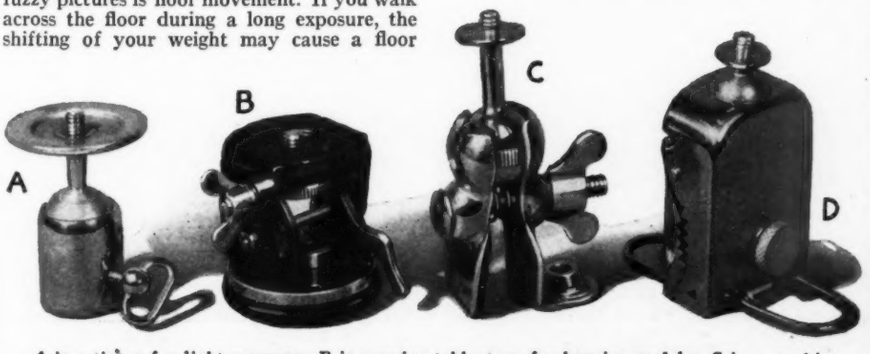
Always let the camera settle for at least fifteen seconds after the last time you touch it before you press the release to make the exposure. Take care, too, that the shutter release is bent in the form of a loose curve so that the motion of your fingers cannot be transmitted to the camera.

Another common source of trouble and fuzzy pictures is floor movement. If you walk across the floor during a long exposure, the shifting of your weight may cause a floor board under a tripod leg to raise or lower a bit, and then you will wonder why objects in the picture show traces of double outlines. Stand still and have everyone else in the room stand still while you are making time exposures unless you are working on a heavy concrete floor.

Whenever there is any doubt about the steadiness of the tripod setting—and always when you are taking a picture with the camera on a tiptop—make the actual exposure by means of a black card held a few inches from the lens. Even pushing the shutter release may cause slight camera movement.

The steadiness of any tripod is at a maximum when the legs are spread well apart. On wooden floors, try to catch the point of each leg in a crack between two boards so that there will be less chance of slipping. When you are cramped for room, the trick shown in the upper photograph on page 74 comes in handy. Using two legs and the wall in this way will allow you to get another couple of feet away from your subject so as to include more of it.

If there is any doubt about the steadiness of the tripod setting, or there are small children playing around, stay within arm's reach of the camera and keep your eye on it!



***A* is a tiptop for light cameras; *B* is a swing-table type for heavier models; *C* is a combination tiptop and camera clamp; and *D* is a clamp for fastening a camera to a tree or branch**

FREE PLANS for THIS BOAT

WITH

IRWIN'S BLUWIN BIT

FOR the benefit of home-craftsmen who would like to make their own row boat for this summer's vacation, we offer absolutely free a complete set of plans which make the job simple.

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There is a tag attached to every "Irwin" Bluwin Bit. Send this tag to The Irwin Auger Bit Company, Wilmington, Ohio, with your name and address and receive free of charge a complete set of working drawings of the row boat pictured above. "Irwin" Bluwin Bits for sale in all sizes by your hardware dealer, or write direct.

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HOME WORKSHOP BLUEPRINTS

New projects are marked with an asterisk (*)

TO ASSIST you in your home workshop, POPULAR SCIENCE MONTHLY offers large blueprints containing working drawings of a number of well-tested projects. The blueprints are 15 by 22 in. and are sold for 25 cents a single sheet (except in a few special cases). Order by number. The numbers are given in italic type and follow the titles. When two or more numbers follow one title, it means that there are two or more blueprints in the complete set. If the letter "R" follows a number, it indicates that the blueprint or set of blueprints is accompanied by a special reprint of the instructions originally published in the magazine. If you do not wish this reprint, omit the letter "R" from your order and deduct 25 cents from the price given. Reprints alone are sold for 25 cents each.

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S. E. 5a World War Plane, 30-in., *168-169*	.50
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(See page 78 for kit of materials)	
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*Galleon *Revenge* (25-in.), *206-207-208-209*	1.00
(See page 78 for kit of materials)	
Galleon, Spanish Treasure (24-in.), *46-47*	.50
(See page 78 for kit of materials)	
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(See page 78 for kit of materials)	
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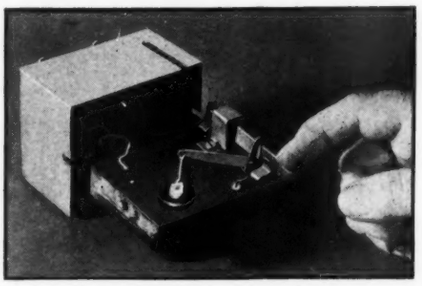
CIRCUIT BREAKER BUILT FOR MODEL RAILWAY

THE simplest way to protect the wiring of your model railway from the effects of a short circuit is to install an ordinary fuse block for taking household type plug fuses. A 5- or 10-ampere fuse will handle the load of a small model railway, and 15-ampere fuses are large enough for an elaborate installation using two or more locomotives. The only trouble with this system is that nearly every derailment means a burned-out fuse, and fuses cost money.

The accompanying illustration shows a simple, home-built circuit breaker. It can be made up from pieces found in most home workshop scrap boxes. The physical design of a circuit breaker can be varied in many ways, but in theory it is always the same. There is a switch that is held closed against a spring by a trigger to which is attached the armature of a magnet. The coil of the latter is wound with only a few turns of heavy wire. This coil is connected into one of the wires that feeds current to the track. The coil has so few turns of wire that the flow of current needed to operate the locomotives has no effect on it, but when a short circuit occurs, the magnet attracts the armature. This pulls the trigger, and the switch flies open, thus breaking the circuit.



When a short circuit causes a heavy current to flow through the coil, the armature pulls down the trigger and the switch springs open

In the circuit breaker illustrated, a coil spring was fastened under the blade of an old knife switch. A piece of sheet metal was cut as shown so that one end hooks over the knife blade when it is pushed down to the closed position. The other end of this lever is linked to a short piece of iron rod, which is pulled down into a brass tube when the heavy current from a short circuit flows through the insulated coil that is wound around the tube.

The circuit breaker may be adjusted so that it will hold for the normal load and trip off on a short circuit either by changing the tension of the spring that holds the trigger in engagement with the switch blade or by changing the number of turns of wire wound around the brass tube. Reducing the tension of the spring or increasing the number of turns of wire makes the circuit breaker more sensitive and more responsive to overloads.—FRANK E. CRANE, JR.

KEEPING MODEL RAILWAY FITTINGS IN SCALE

IF YOU want to start a hot argument among a group of model railway fans, all you have to do is bring up the subject of scale dimensions. A number will maintain that sticking to scale—in other words, making each part of a model an exact scale reduction of the prototype—is of vital importance.

As a matter of fact, every ardent advocate of strictly scale model making has to compromise on more dimensions than he cares to think about. In *(Continued on page 83)*

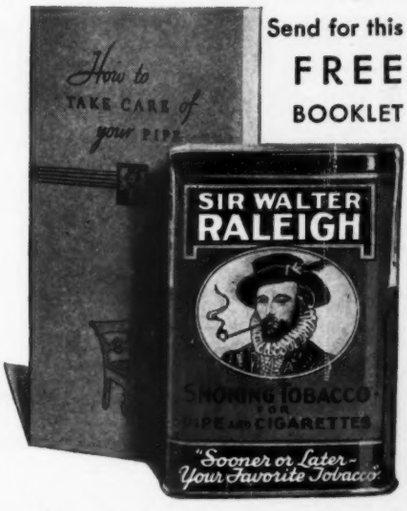
FREE
advice *to* Brides!

"HERE'S a way to avoid getting into hot water with your husband. Most husband troubles, like most hot water troubles, are caused by faulty pipes.

"The symptoms of a faulty pipe are black clouds of foul-smelling smoke spreading through the new home like tidal waves.

"No need of it, girls. Get your husband started on Sir Walter Raleigh Smoking Tobacco in a well-kept pipe, and you'll never have anything but happiness. Neither will he. For this tobacco is a mild, satisfying mixture of rare Kentucky Burleys that delights both sexes. I bring it to you *fresh*, wrapped in gold foil. Here's a book I've written about keeping a pipe. I might have called it, 'How to Keep a Husband.' It's valuable, and it's free to brides (and everyone else)."

Brown & Williamson Tobacco Corporation
Louisville, Kentucky, Dept. Y-37



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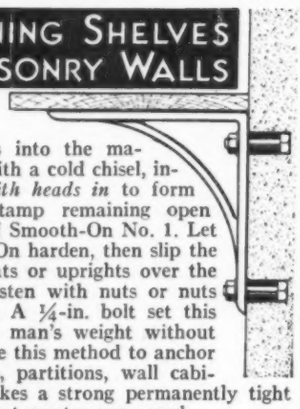

CUT holes into the masonry with a cold chisel, insert bolts *with heads in* to form studs, and tamp remaining open spaces full of Smooth-On No. 1. Let the Smooth-On harden, then slip the brackets, cleats or uprights over the studs and fasten with nuts or nuts and washers. A ¼-in. bolt set this way holds a man's weight without loosening. Use this method to anchor cellar shelves, partitions, wall cabinets, etc. Makes a strong permanently tight connection that meets every need.

Use Smooth-On No. 1 also to stop leaks. Seals joints and cracks in pipes, boilers, radiators, etc. Tightens loose handles, locks, hinges, casters, hooks, stems, etc. Makes stripped nuts, bolts and screws hold. Stops leaks in auto radiators, hose connections, cracked water jackets and gear cases, oil and gasoline lines, keeps nuts, lubricator connections, hub caps and wood screws from coming loose, makes dash supports tight and proof against rattle.

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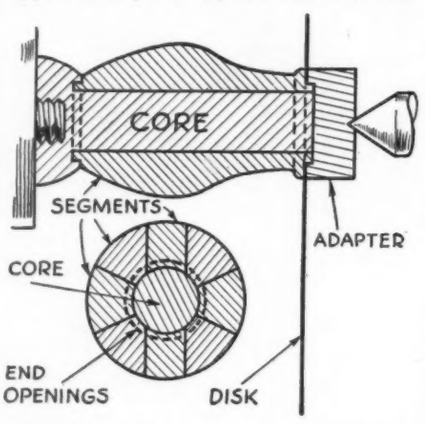
Hints on Difficult Metal Spinning

By HERBERT WOOLSEY

SOME articles spun from sheet metal look as if they had been shaped over sectional forms such as were described in the preceding article in this series (P.S.M., June '33, p. 76), but in reality they were made by a different method. If you recall the ash-tray job described in a previous article (P.S.M., Apr. '33, p. 76), you will remember that the bottom flange was turned over while the work was held in a hollow wood chuck. By a similar method, shallow bowls or pans with turned-in sides can be made, and other objects of similar nature produced. However, for the production of a number of pieces of exactly the same shape, nothing can replace a sectional chuck.

Hollow articles having openings smaller than the maximum diameter of their interior can be spun without the use of any inside support if they are very small in size. Thus



Chuck designed for work open at both ends and of greater diameter in the central part

a constricted ring can be spun around a small, closed cylinder if the closed end is allowed to project beyond the end of a core. The smallness of size produces a stiffness that makes this possible.

There is another type of sectional chuck that can be used without previously forming the work on a one-piece chuck. This type is employed for making articles open at both ends, such as a hollow knob that can be slid along a rod or tube.

The parts making up such a sectional chuck are formed with a projecting collar on each end. That at one end fits in a groove around the core, while that at the other end passes through a hole in the center of the blank, and is thus held securely enough to permit spinning, as shown in the accompanying diagram. Further security is obtained by using a steel back-center button so shaped that it fits over the projecting collar beyond the blank.

Another form of spinning that may puzzle the novice is the making of a tubular object, open at both ends and with the center smaller in diameter than the ends. The rims on which some airplane tires are mounted take such form. The chuck used in such spinning can be made to separate at the middle, so that each half will come out of its end of the work. The piece is spun from a flat disk, the center being cut away subsequently to open one end.

The photo in the next column shows a form of this type which is used in producing the constricted part of a lamp-post knob. The remainder or tip of the knob is spun on forms similar to those employed in making spheres (P.S.M., May '33, p. 69), and is soldered to the lower piece. The two left-hand pieces of the chuck shown were made of aluminum, while the form over which the tip is spun is of steel.

This use of steel and aluminum or other

The first two pieces are part of a sectional chuck on which the lower part of the knob shown at the right was made. The top of the knob was spun on the pointed form (the third piece) and brazed to the lower section

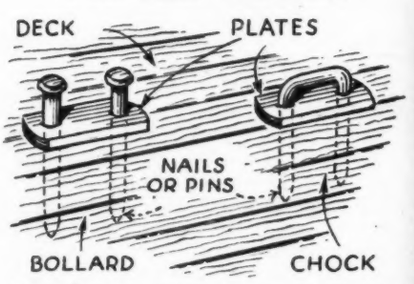
metal is not entirely a matter of taste or availability of materials. Soft metals can be used where curves are gentle and the metal is not drawn excessively in spinning. However, when sharp changes in contour are made, or pointed objects produced as in the case of the lamp-post knob, steel is necessary because of its greater strength and resistance to wear.

Spinning is not confined entirely to round objects, for some articles you encounter almost every day are oval in shape, yet were produced on a spinning lathe. The making of such products, however, requires a special chuck that is beyond the resources of the average small shop.

The production of rolled edges or beadings often involves the use of special equipment. Nevertheless, by employing a tool that consists of pulley with a concave groove, mounted in a slotted steel handle, any spinner can turn edges over to a nicety. Simply start the metal with a pointed tool and turn it as far as possible. Then use the pulley wheel to "tuck it in." Other wheeled tools are used for special work, such as the spinning of grooves.

The subject of spinning is too extensive to be covered completely in so brief a manner as in this series. An effort has been made in this and the four preceding articles to introduce the novice to the more important details of the art. Ingenuity and experience can be depended upon to lead the way to more complete mastery.

CHOCKS AND BOLLARDS FOR SHIP MODELS



Two suggestions for making small chocks and bollards from flat plates and pins or nails

CHOCKS and bollards for ship models are easily made by cutting cardboard or thin metal to the proper shape, gluing or cementing it to the deck, and driving pins or nails in as shown. If brass or other metal is used, holes will have to be drilled for the pins, and the pins may be soldered to the plate. In the case of bollards it is advisable to use escutcheon pins rather than common pins because the heads are a better shape.—R. J. H.

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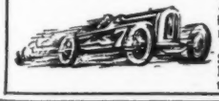

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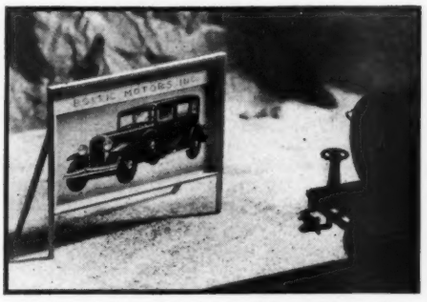
KEEPING MODEL RAILWAY FITTINGS IN SCALE

(Continued from page 81)



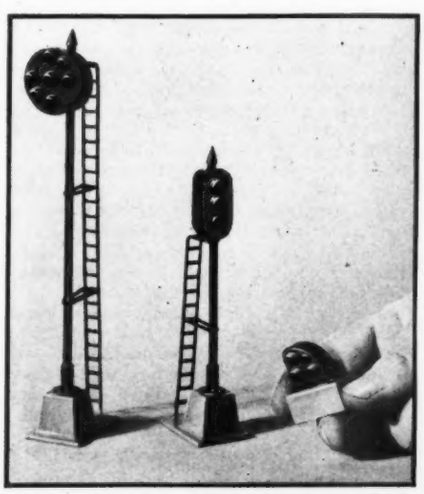
Model signboard built to the correct scale. The picture was taken from an advertisement

"O" gage, for example, making a steam locomotive absolutely to scale would be a task so difficult that only a man equally expert in diesinking, tool making, and in the building of fine watches could hope to succeed. On the other hand, all model makers should work to the correct dimensions whenever it is possible.

Beginners are specially likely to overlook this point. They often make things way out of scale when it would be just as easy to make them the correct size. Telegraph poles made of ⅜-in. dowel rods instead of ⅛ or 3/16 in. in diameter are an example.

This point is well illustrated in the photograph above. It is common practice to make model signboards to decorate the right of way, but they are often so clumsy and heavy that all realism is lost. This sign is an advertisement cut from a magazine. Around the edges have been glued strips of wood 1/16 in. thick by slightly less than ¼ in. wide, set edgewise. The vertical strips project downward to form legs. Two additional pieces were cut off at an angle of 60 deg. and glued to the back to form supports. The same construction will work out equally well if you use heavy cardboard cut in strips, provided you shellac the cardboard framework, legs, and supports so they won't sag. How much less attractive this signboard would be if it were framed with heavier strips and had thick, stumpy legs and supports!

Of course, the more elaborate the model—especially if it has moving parts—the more difficult it is to stick to scale. The photograph below, however, shows what can be done along these lines with the building of model signals. Electric light bulbs no larger than a small pea were used, and the position light contains seven of them.—T.W.A.



Even as intricate signal apparatus as this can be kept very nearly to scale proportions

10,000 *Skippers said "YES, we use* PLASTIC WOOD"

It sounded like 10,000—the answers came so fast. It all started when the boss said, "Write an ad about Plastic Wood for boat repairs". Now, I know what great stuff it is on land, with workshop fans—but at sea?—and me, a flabbergasted, advertising landlubber!

I jumped into my buggy and spent a day hopping from one boat yard to another, along the Connecticut Shore. Some of those guys talked so fast, my pencil broke down trying to keep up. But I remember most of what they said. It goes like this—Plastic Wood for refilling rotted cavities around loose bolts, for repairing stem dents—for reshaping plank edges and splintered ends, for covering countersunk screws, for repairing checks in spars, for strengthening joints in body work. "And that goes for fresh-water boats, too," one skipper yelled.

The boss said, "Fine, but you left out a few dozen other uses. Better tell Popular Science Readers we have a special, FREE book on Plastic Wood for Boats. Lot of good dope that will save them money on repairs—and put their boats in sailing trim. And tell them Plastic Wood can be worked like wood—scraped, planed and pointed. It's as easy to handle as putty—and it's economical."

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HUNTING WATER LIFE FOR YOUR MICROSCOPE

(Continued from page 37)

the layer just removed. Animal or vegetable? This is still a moot question.

In water from the bottom of a stagnant pool, we find another interesting form of life called desmids. These are single-celled plants, so nearly transparent that we can see the protoplasmic transformations that are constantly going on within them. Here is a whole afternoon or evening of enjoyment in itself.

WE SEARCH decayed vegetable or animal matter for the eggs of the common house fly (Diptera or two-winged class of insects). Sooner or later we find them, transfer a few to a slip glass along with a bit of the decayed matter, and place them under the microscope equipped with a low-powered objective. No need for long waiting, for the house fly, as we all know, is a fast breeder. In two days the eggs have hatched and the larvae set about feeding on the decayed matter. Six days of this and they enter the pupa stage. The fully developed insect comes after some seven days in the chrysalis form and the amateur microscopist can follow this entire development.

Further study of the ordinary house fly may be carried on profitably. We capture a big fellow, give him an alcohol bath, and proceed to dismember him with our operating equipment. A wing is pulled off with the tweezers, placed on a slide, and examined. Nature is a masterful airplane designer as we shall note. A leg is clipped off at the body joint with the tiny shears or a razor blade. It is slipped between two glasses and placed on the stage. Now we see how flies so easily climb the wall and walk on the ceiling. Powerful claws form each foot in addition to bristles with which the fly grooms itself. We cut out an eye, place it on a glass and slip a high-powered objective (300 diameters) into place. We notice the eye is covered with dots resembling honeycomb construction. Each dot is an eye in itself —a thousand eyes in one.

THE same process is carried out with the mosquito, starting with the larvae. A large colony of these pests may be started by merely placing a bucket of stale water, taken from a mud puddle, in a sunny spot in the back yard. If we replace the water as it evaporates, we shall notice in a short time, little objects moving about by flipping their tails. They are small but may be seen with the naked eye. Some of them are scooped into a glass and placed in a water cell. Only a lower-powered objective is necessary to study these insects. The mosquito is not an aqueous animal. It has to breathe and while it lives in the water it cannot take its oxygen supply from it. The periodic trips of the larvae to the surface are noticed. Each insect pokes its breathing apparatus through the water surface, sucks air, and drops back.

Now we can understand how the Government experts kill countless billions of these pests every year. The objective of the microscope is set on a line with the surface of the water in the water cell. By moving the cell, we may then sweep the whole line of the water surface. A single drop of heavy oil is placed on the surface of the water with a medicine dropper. It immediately spreads out into a thin, tough film. Up come the larvae to breathe. They push against the oil film. It is elastic and we see it give under the pressure but it does not break. Again and again the insect struggles to break through to the source of life-giving oxygen, but the film holds and the larvae at last sink to the bottom of the vessel dead.

Everywhere there is work and fun for the amateur microscopist. The more serious students are strongly advised to read one or more elementary books on biology and botany.

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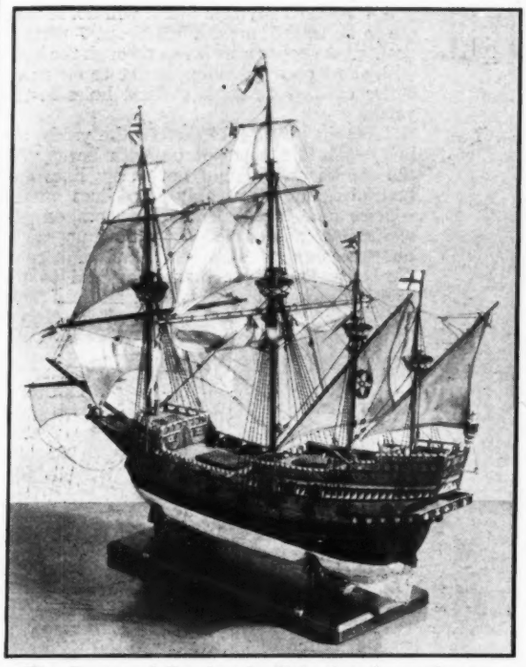
RIGGING OUR NEW GALLEON MODEL

(Continued from page 66)



The *Revenge* fully rigged. Note that the yards are slightly braced up as if for a wind on the quarter

and through that putting a small escutcheon pin, so that the deadeyes will all be tight down on the channels and the nails on one level. Note on the rigging plan, published last month, that they are spaced to miss the muzzles of the guns.

Now, into one end of a piece of *a* cord, seize a deadeye. Pass the other end up through the top, around the masthead, and down the same way on the starboard side. Fasten another deadeye to lie level. Wax a piece of *c* cord, put a knot in the end, reeve it from inside out through the top deadeye, outside in through the lower, and so on. Do this for both and haul tightly together, tying the ends off and adding a spot of glue above the top deadeye. Do this on alternate sides until all are complete. Where there is an uneven number of shrouds, pass the first up one side and down the other. Get them good and tight, balancing the stays, with the masts at the correct angle, as shown.

Bore a hole fore-and-aft in the fore and main topmasts ⅜ in. from the squared upper part. Make the crosstrees *27* and caps *28* as before, only smaller. (A complete key to the identifying numbers used in the text was given in last month's article.) Smaller crosstrees and caps can be made at the two aftermasts for the flagstaffs, and also at the topgallant mastheads.

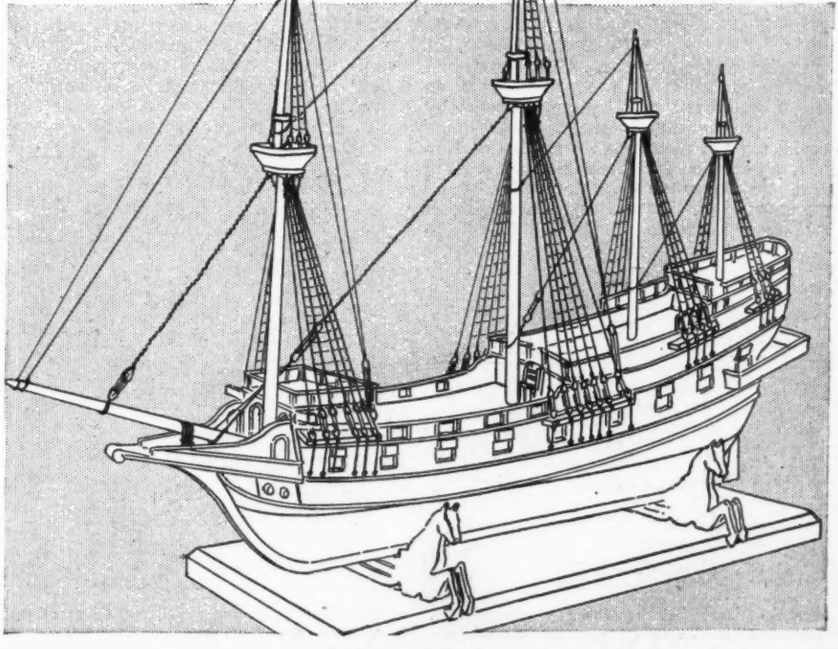
Reeve the fore and main topmast stays *29* and *30* of single size *a* cord, splicing or neatly seizing an eye at the top. Hitch the forestay to the bowsprit end, and the main to the foremast just under the cap. The after topmast stays *31* and *32* can be of *b* cord hitched to a notch in the mainmast and the nail in the mizzenmast.

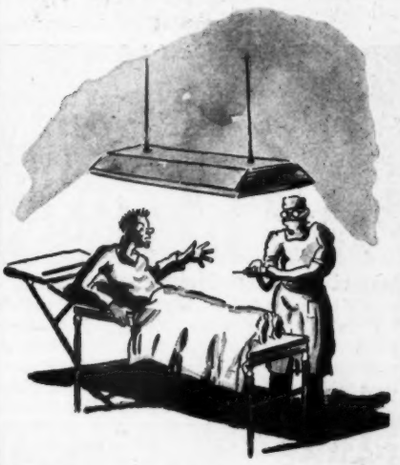
The topmast shrouds *33-36*, three on a side, are of *b* cord. They are carried around the masthead as before and brought down to other deadeyes in the tops. The lower deadeyes here are hitched to cord instead of wire. The cord is passed through the holes in the top and fastened to the lower shrouds, but as they are awkward to reeve when in position, reeve them loosely first, bring them down close, and then tighten up the lanyards. Two shrouds to a side will be enough at the mizzen and bonaventure topmasts.

From the fore and main

(Continued on page 86)

A simplified sketch to show at a glance the standing rigging. Much depends on getting this neat, uniform, and tight





"Hey Doc,

—is that Needle Oilstoned?"

Scientific expeditions spend many months in the field thousands of miles from civilization. Limited for space, they have to take great care of their few surgical instruments.

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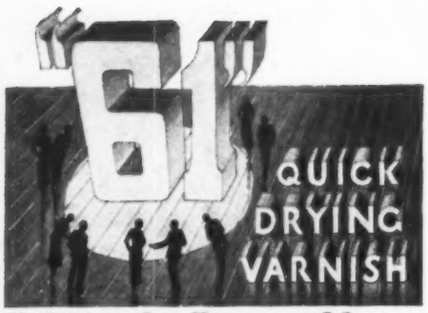

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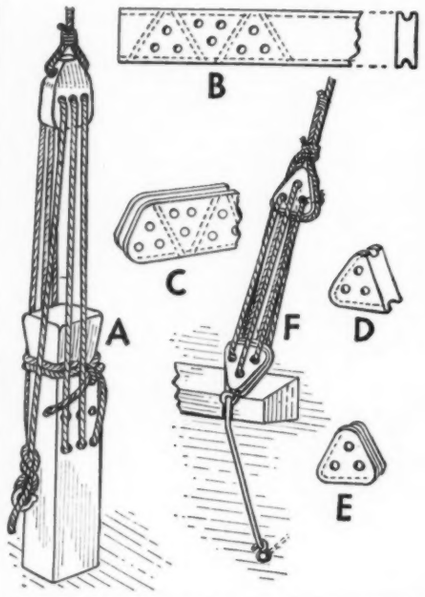
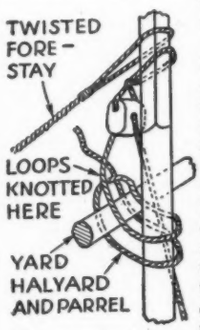
RIGGING OUR NEW GALLEON MODEL

(Continued from page 85)



How deadeyes are made and used and method of reeving the main-yard halyard to a knight

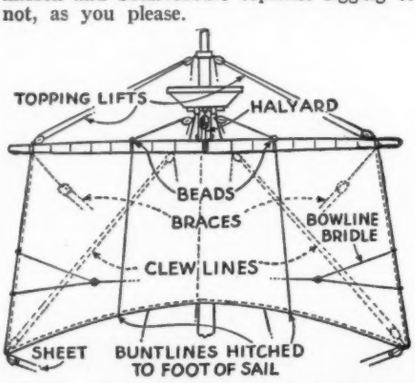
topmast-heads come also preventer backstays *37* and *38*, which are hitched to the masthead. One end comes down each side, with a single ¼-in. block in each end; then another block is tied to the bolts in the channels and the two brought tight with a fall (rope) of *b* cord.



Using end of halyard for a parrel

The fore and main topgallant masts *39* and *40* are shipped through the topmast caps to the crosstrees, with stays *41* and *42* of *b* cord, fixed as for the topmast stays to the positions shown. Two shrouds *43* and *44* each side will be needed, coming over notches in the ends of the crosstrees. They are hitched or seized to the topmast rigging.

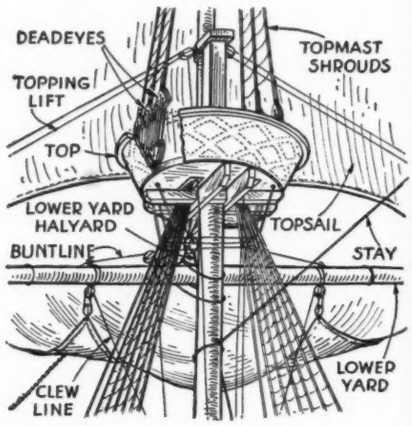
Now the shrouds will require ratlines, or steps. These should be of silk or sewing cotton about size 60. They should be clove-hitched to each shroud. It is up to you if you want to shorten this work by hitching to the outside shrouds and simply reeving around the others. A spacing of 3/16 in. is a bit wide for them, but looks about right. You can rattle down the topgallant and mizzen and bonaventure topmast rigging or not, as you please.



Front of mainsail before it is clewed up. Note buntlines, clew lines, and bowline bridle

For the sails any thin fabric will do. If they are to be bellied, make them about 7 percent deeper. A copper wire is run through the hem, with short ends extending at the top corners. These ends go through vertical holes in the yards.

After the sails are hitched to the yards, the bowline bridles are put on with beads. All the square sails should have clew lines and buntlines, but I put only clew lines on the courses and topsails, and buntlines on the mainsail because I clewed that one up, without stiffening it. This gear is all of *c* cord. The clew lines have blocks fastened to the clew, or corner, of the sails themselves (note particularly that they are *not* fastened to the yards) and another under the yards near the middle.



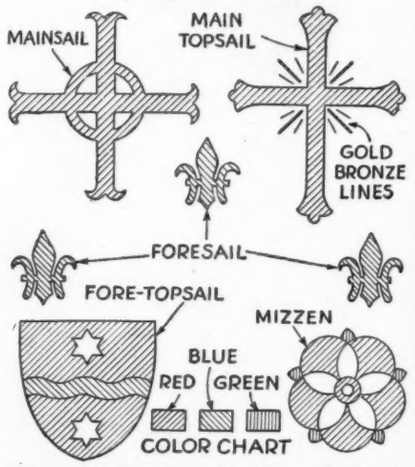
One of the mast tops partly broken away to reveal the deadeyes of the topmast shrouds

The sail devices can be painted on one or both sides as shown below.

The foresail and mainsail have ¼-in. sheet blocks, with *b* cord rove through.

To set up the fore or main yard, take the end of the halyard, which was previously rove off to the knight as shown at *A* in the drawings at left above; pass it down on the fore side, around the mast, up around the yard, and around the mast again, as shown in the small drawing in the adjoining column. Finally, hitch the end to the first part and the standing part. This will serve as a parrel. Reeve off the topping lifts with *b* cord from the yardarms to the blocks on the cap. Haul these tight to make the yard lie horizontal, and hitch to the handrail.

(To Be Continued)



Designs used on the sails. The small areas without crosshatching should be left white

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Replacing Bolsters on Farm Trucks

By L. M. ROEHL

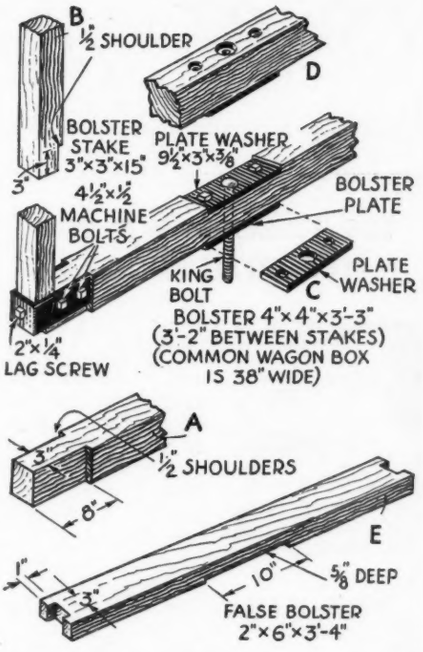
New York State College of Agriculture

THE kingbolt of a low farm wagon often wears down into the bolster and weakens it, or the end of a bolster becomes damaged so that a replacement is necessary.

A piece of oak, maple, or other hardwood 4 in. wide, 4 or 5 in. thick, and 3 ft. 3 in. long may be used. A piece 4 in. wide is preferable to a narrower piece. If the clevises are only 3 in. and the bolster is wider, it is cut as at *A*.

If the bolster stakes are broken, new ones are made as shown at *B*, with a ½-in. shoulder at the lower end to rest on the bolster end. The stakes are held in place with 2 by ¼ in. lag screws.

The holes in the bolster plate on the underside of the bolster should be countersunk on the lower side. To prevent the head of the kingbolt from wearing into the bolster at the top, one of three methods may be used. An iron plate *C*, 9½ by 3 by ⅜ in., is made with holes of the same size and in the same position as those in the bolster plate. The plate is set deep enough into the bolster at the top so that the heads of the bolts and kingbolt will allow the wagon box to rest evenly on the bolster. Two 5½ by ½ in. machine bolts may be used to fasten the plate washer and bolster plate in place. The threaded ends of the bolts are cut off so as to leave projecting ends of 3/16 in. They are placed from the top; then the bolster is inverted so as to allow the bolt ends to rest on an anvil, and the bolt ends are riveted into the countersunk plate.



How to make a new bolster and prevent the kingbolt from wearing it out too quickly

Another method is to make holes *D* in the bolster at the top to allow the heads of the kingbolt and other bolts to drop in flush.

If a false bolster *E* is used, the plate washer need not be set in, as the underside of the false bolster is cut out as shown.

CIRCULAR SPOOL HOLDER SAVES SEWER'S TIME

The complete sewing kit

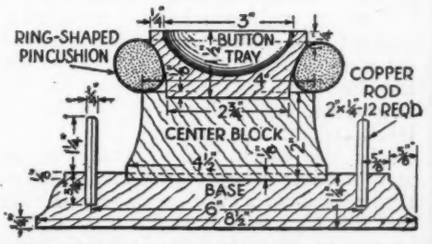
THIS spool holder is admired by every woman who sees it—and rightly so, as a woman suggested the arrangement.

The wood I used was alder, but walnut, mahogany, or oak would be equally suitable if stained; and for an enamel finish any soft wood could be used. The dimensions were arrived at after careful study and should not be changed by more than a small amount.

The button tray on top is first turned; then it is stained and polished while still in the lathe, using either wax alone or a shellac finish, oil polished and with wax as a final coat. Next the center block is turned, and a depression ⅛ in. deep cut in the top so that the bottom of the button tray is an easy fit. This is not finished at this point. The base is now turned to size. Leave it on the faceplate until all the following steps are completed. First, a depression ⅛ in. deep is cut in the face to receive tightly the bottom of the center block. Then the circle of holes is drilled for the spool pegs, which are of ¼-in. copper rod cut 2 in. long, but don't put them in until the very last thing. The holes are 1/64 in. under size so as to be a driving fit, and are ¾ in. deep. Make them all uniform in depth. Now glue the bottom of the centerpiece, put it in place, and run up the tail spindle of the lathe as a clamp. Wipe off the surplus glue and let dry overnight.

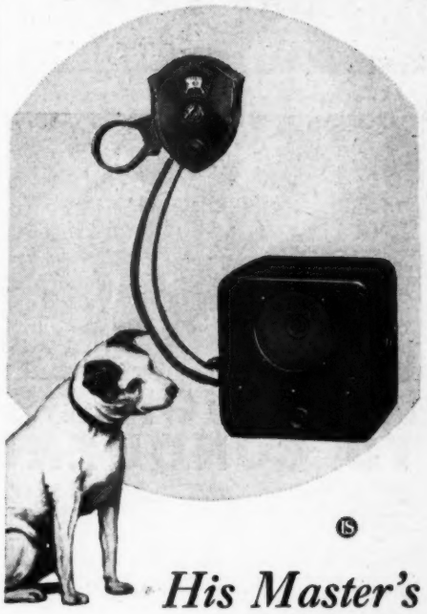
When thoroughly dry, stain and finish these parts in the lathe; then set the pincushion in place around the base of the button cup, apply glue, and clamp by using the tail spindle as before. Let dry, remove from the faceplate, drive in the polished pegs, and glue paper or cloth to the bottom.

The pincushion is made of velvet in a harmonizing color. It really is a velvet doughnut. Be sure to cut the cloth on the bias, then sew into a long roll, and stuff with wool. Bend it into a circular shape to fit snugly around the base of the button tray and sew the ends together. It need not be glued; if care is taken it will fit tight enough in the groove provided for holding it.—H. D. ALLEN.



This sectional view shows how the parts of the spool holder are shaped and assembled

LISTEN!



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(Please print plainly)

*Name*_____ *Age*_____

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HIS TRAVELING STORE MET WITH SUCCESS

WILLIAM had worked for me as a stenographer for about three years. A year or so ago our business, along with a great many others, all but evaporated, and it was necessary to cut down on all fronts.

William had to go; we regretted it, for this twenty-three year old lad was ambitious and intelligent—an unbeatable combination. For some years, he had been studying the Spanish language very diligently. In fact, it was a specialized subject with him, as he was eventually aiming for a college professorship.

Just about the time William started hunting for a job that would not only support him, but also help pay for his studies, his brother returned home from the Middle West, where he had been working in the retail grocery business. Now he, too, was out of a job.

The boys live in a well populated, suburban town on Long Island, N. Y. Casting about for something to do, they fell back on their *combined* knowledge of the grocery business. Finally, they came out with an idea. They would start a traveling grocery store. It sounded good, so they scouted around and found a large, second-hand automobile truck, which they bought on a time payment basis. They set to work and fitted the sides with handsome panels, proclaiming the nature of their business. Inside, the truck was fitted with all sorts of bins and shelves. The next step was to turn the large, clean and dry basement of their home into a stockroom and thus eliminate any rental overhead. Negotiations were opened with wholesalers, and a line of staple products secured at reasonable prices.

WILLIAM had the looks, so he became the salesman. He got busy visiting homes in the nearby residential sections. His plan was to solicit orders by offering certain daily specials at extra low prices, and soon he had built up a sizable list of customers. The boys worked out a system of soliciting business in the mornings and making deliveries in the afternoons. William's brother handled the truck and did the buying.

The idea caught and it became necessary to cover a larger sales area, so William picked up a very cheap second-hand car for his route. Pretty soon orders started to come in by telephone. They were established! *(Continued on page 89)*

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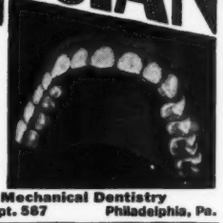

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Secrets of Success

HIS TRAVELING STORE MET WITH SUCCESS

(Continued from page 88)

Of course, chain store competition has to be met, but a large item in their favor in keeping prices down has been the elimination of store rental and clerk hire. Now their business has grown to such proportions and covers so large a territory, that they are seriously considering the purchase of another truck.

This little business was not built up in a day. It took the perseverance and persistancy of youth and ambition to put it eventually on a sound basis. For William it has accomplished one thing: supplied him with an income which will enable him to continue his studies. For, although this idea has the possibilities of a large business, I don't think it will satisfy William for long. He still has his eye on a professorship in at least a small college.—H.M.W., New York, N. Y.

• • •

STRANGE PLANT NURSERY A GROWING SUCCESS

MY FATHER, James Hard, Junior, came to Florida twenty-three years ago. For reasons that have no place here, he had decided to leave the old Tennessee home and seek his fortune elsewhere. Florida, then a new and alluring land, beckoned strongly. So Florida it was.

He settled down in the small town of Saint James City, which is on a tiny island on the Florida West Coast, some thirty miles from the mainland. In those days the surroundings were virtually primitive, and the life almost a pioneering one. For many years my father operated a small store, and found it an extremely difficult means of making a living. After all, there were only ninety-eight people on the end of the island where we lived!

In 1931 the store was on the verge of failure, and he decided it was time to make a new start. But there seemed little that could be done. It was too late now to begin again somewhere else, and the little island naturally had its limitations. However, he did find something.

Some years before, there had been a rope factory on this island. They had devised a process of making rope out of the sisal plant and, for the purpose of extending their operations, this company had planted these sisal plants extensively all over the island.

After a few *(Continued on page 90)*

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Secrets of Success

STRANGE PLANT NURSERY A GROWING SUCCESS

(Continued from page 89)

years of indifferent fortune, the company folded up and departed. Now—and this is years later—there are thousands of these sisal plants growing here. To the unaccustomed eye they present a strange sight. A spiny stalk supports the plant, and around the base are long, fleshy leaves, lying close to the ground, somewhat like an ornamental rosette in appearance. After about six years, the main stalk reaches a height of fifteen or more feet. The leaves are colored varying shades of green, with white striping.

Father's idea, of course, was to cultivate these plants for ornamental purposes. He gathered a few plants of different colors and also several species of cactus and agave (very similar to sisal). These he planted in a small cultivated area. He was anxious about their growth, as they naturally grow wild, in thick brush and swampy places.

The venture was successful. The plants thrived. Now he has over an acre cultivated. He has sold thousands of these plants to nurseries on the Florida mainland and has shipped them all over the world. Sisal and agave have become quite popular for rock gardens. They seem to thrive nicely in most temperate climates. The business has grown steadily and has become quite profitable. It is certainly better than trying to make a store pay on this little island, and the work is pleasant and healthy. All of which makes for success.—L.L.H., St. James City, Florida.

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THIS department will give $5.00 for every true success story submitted by readers of Popular Science Monthly, and which is accepted for printing in this magazine.

Manuscripts will be judged on the individual merits of the case and circumstances involved. Only stories in which the author's success, or that of some one known to the author, has been gained by some method of educational guidance, fitness for the job, or application to the work will be considered. We are not looking for the "get-rich-quick" type of story.

Manuscripts must be confined to 500 words or less. They must be true and, if accepted, authors must be prepared to give us signed statements to the effect that they are true. Manuscripts submitted and printed become the property of this magazine, and we are not responsible for the return of rejected stories unless postage is provided for this purpose. Address contributions to Success Story Department, Popular Science Monthly, 381 4th Avenue, New York City.

HISTORY'S BIGGEST SHOW REVIEWS GREAT CENTURY

(Continued from page 27)

fantastic specimens. Before this remarkable micro-vivarium display could be put into operation, a whole new method of mounting the water drops, to prevent their evaporation under the intense light, and to keep the tiny creatures alive, had to be perfected.

Mirrors, in a nearby exhibit, reflect in a container of liquid an animated drawing of budding yeast cells to demonstrate the process of fermentation. The cells, projected into the fluid instead of upon a screen, appear to bud and multiply within the container, each cell enlarged to giant size.

A twelve-foot cornstalk, showing how plants make food from sunshine; a mechanical twig which puts on a year's growth of new cells in seventy-five seconds (P.S.M. Apr. '33, p. 24); and a papier-mâché cow that gives real milk (P.S.M., May '33, p. 33), turn other phases of scientific knowledge into fascinating exhibits of action. Much as POPULAR SCIENCE MONTHLY pictures the drama of scientific advance from month to month, the whole exposition presents the broad sweep of knowledge gained during a century of spectacular progress.

COVERING one whole wall is an immense plant map of the world, divided into 500 sections. Each represents a special type of vegetation area. These areas light up in units so you can see at a glance the desert, forest, and barren-land sections of the world. The huge map is made of glass, sprayed with aniline dyes and lighted from the rear. Oil paintings show in detail typical scenes in the different vegetation areas, ranging from the tropical jungle to the Arctic tundra, and picture the plants and animals common to each.

Probably the most elaborate single exhibit of the exposition is the world's largest diorama, a ninety-foot combination of models and paintings which tells the story of the generation, transmission, and uses of electricity. Rushing mountain streams spin the turbines of diminutive power stations, high-tension lines, built to scale, lead across the countryside to model towns and cities, where, on a twenty-four-hour cycle, the hundred and one uses of electric current are illustrated in miniature.

Revolving tubes of glass, lighted from within and having nine different-colored sides, produce the lighting effects which run from sunrise through the day to darkness. A complete cycle takes place every three minutes. For five months, nearly a hundred men worked in a studio preparing this single diorama.

SIMILAR plastic pictures, on a less elaborate scale, show Benjamin Franklin drawing electricity from the clouds, prehistoric monsters feeding amid the earliest forms of vegetation, natives cultivating pineapples and tapping rubber trees, and a miniature blast furnace converting raw ore into steel.

Everywhere you find information dramatized, processes shown in action, facts and information revealed in thrilling exhibits. The exposition is an encyclopedia brought to life.

A whole orange grove has been transported bodily from Florida, a redwood tree has come from California, and a twelve-foot waterfall, flanked by live birch, fir, and spruce trees from Michigan, reproduces in every detail a scene in the northern woods.

A glass automobile and a glass refrigerator enable you to see the mechanisms operating inside, and an infinite variety of products ranging from tooth paste to soft drinks take form and are bottled, canned, or placed in tubes while you watch. More than a score of large American corporations have taken space at the exposition to show in action the processes by which their products are manufactured.

Overhead, the rocketlike cars of the million-dollar Sky-Ride, shoot between their 625-foot towers of steel. Amphibians shuttle back and forth; observation balloons hover in the air and passenger-carrying blimps cruise above Byrd's Anarctic ship, anchored in the lagoon; the gold-roofed Lama Temple of Jehol, brought from the Orient in 28,000 separate pieces, and the Enchanted Island with its Magic Mountain are other wonders on display. In this Land of Make-Believe, children find a coaster wagon thirty-five feet long, a marble six feet in diameter, a Tin Woodman of Oz twenty feet tall, a fence made of wooden elephants, and an enormous sailor whose arms revolve with the wind.

IN THE great Pageant of Transportation, you see depicted the dramatic advance from the ox cart and the *Clermont* to the modern automobile and the latest greyhound of the sea. "The World a Million Years Ago" (P.S.M. June '32, p. 16) shows you monsters of the past in their natural surroundings. The architectural exhibits carry you from the rude log cabins of Fort Dearborn and Lincoln's day to the most modern dwellings—and beyond to a projected House of the Future.

Daring innovations in architecture form a striking feature of the buildings which house the exhibits. There are windowless walls, sky-hung roofs, metal structures that expand and contract with heat and cold. Dramatic effects are achieved through illumination by cascading colored lights. By night, the fairground becomes an immense rainbow of glowing tubes and varicolored bulbs, surrounded by miles of "mist-light fountains," billowing clouds of vapor illuminated in colors from within.

In fact, to take care of the water needs of the exposition, a water plant of 300,000,000 gallons capacity will operate twenty-four hours a day. Ten miles of water mains form an underground network and there are five miles of storm sewers to take care of emergencies. Facilities for a city of a million inhabitants are required for the visitors at the Century of Progress.

When the star ray which opened the exposition left Arcturus on its forty-year journey to the earth, the Chicago fair of 1893 was in progress. Among the exhibits, there was no automobile, no airplane, no radio. The final forty years of the 1833-1933 century, alone, cover practically the whole history of applied electricity, all of the wonders of the airplane, the movies, the radio, and other laboratory miracles which have become part of everyday life. In invention and scientific discovery, the century just past was the most fertile of all history.

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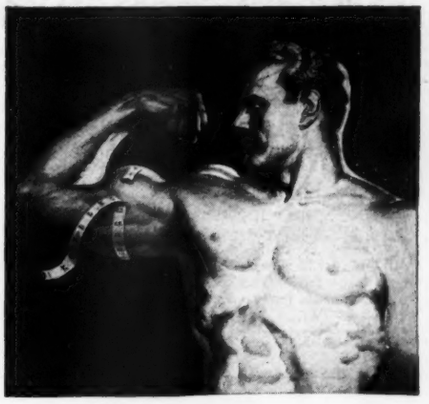

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(Continued from page 11)

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Now consider the steam engine. It loses no power at all with altitude and *gains in efficiency the higher it goes!* This is because the pressure on the exhaust is less in thin air than at sea level. Thus the perfection of the flying steam engine is a vital step toward conquering the stratosphere.

Realizing these facts, inventors in various parts of the world have been working toward the goal achieved by the Besler brothers. In Akron, Ohio, last fall, a local inventor, Harold C. Johnson, announced the completion of a steam engine with two opposed cylinders, weighing, complete with boiler, only 146 pounds.

Some months earlier, it became known that the Great Lakes Aircraft Company, at Cleveland, Ohio, was working upon an experimental steam-driven biplane. Recent dispatches from France reported that a Paris mechanic had perfected a light steam power plant for airplanes. Another news item, coming from Sweden, told of steam-turbine engineers who are working on a new-type turbine for aircraft use, while a third, from Italy, carried the information that G. A. Raffaelli, an aeronautical engineer, had announced a steam engine for stratosphere machines.

But it was the two California inventors, carrying on their secret researches, who first achieved the long-sought goal of steam-driven flight.

Ever since Henri Giffard, in 1852, navigated the air in the world's first dirigible, creeping along near the outskirts of Paris at seven miles an hour propelled by a clumsy three-horsepower steam engine weighing 462 pounds, there have been proponents of steam power for aircraft.

Many of the pioneers of flight, before the perfection of the gas engine, sought to fly by steam. In 1894, Sir Hiram Maxim, the English inventor, spent $200,000 building a gigantic multiplane weighing 8,000 pounds and having a wing area of almost 4,000 square feet. Driven by a 363 horsepower steam engine and two eighteen-foot propellers, the giant craft reached thirty-six miles an hour on special tracks built to hold it down during the preliminary tests. Its lift at this speed was so great that it tore loose from the tracks, crashed over on one side, and demolished itself.

Two years later, Samuel Pierpont Langley, secretary of Smithsonian Institution, Washington, D. C., saw his sixteen-foot model fly for half a mile above the Potomac River propelled by a miniature, seven-pound steam engine, developing one and one-half horsepower. The full-sized tandem monoplane which Langley patterned after this model in 1903 and which was broken in launching, carried a gasoline motor instead of a steam power plant.

After 1903 and the success of the Wright Brothers, steam power for aircraft was practically lost sight of. Gasoline engines made such rapid advance in lightness and reliability that they came into universal use in aviation. Recently, however, the advantages of steam power have again been attracting an increasing amount of attention.

With the first experimental machine already climbing into the air at Oakland, steam has, at last, been harnessed to work in the sky. Experts are watching the progress of the inventors with the keenest interest. Their machine is a definite step toward the huge, winged steamers of the sky visioned by pioneers of flight.

AUTO GLASS THAT'S CRASH-PROOF

(Continued from page 56)

"What's the secret of the stuff?" inquired Kennedy as he examined the cracked surface of the safe glass.

"It's no secret," replied Gus. "Safe glass is made of two polished pieces of plate glass cemented to a center sheet of transparent plastic material like celluloid. This center sheet is tough yet pliable and holds the outer and inner glass in place when it cracks.

"THIS black edging," Gus continued, "is a waterproof cement that seals over the edge of the plastic filler. After the two sheets of plate glass and the center sheet are bonded together under pressure and heat, the sheet of safety glass is dipped in acid. The acid eats away the plastic filler and forms a shallow groove around the sheet. When cement is forced in this groove, the plastic center is sealed in airtight. Moisture and air can't get at it."

Joe Clark, standing in the garage doorway, listened intently as his partner explained the process. "Do you know how they discovered the stuff?" he called when Gus had finished.

"About thirty years ago some French scientist was using a sort of liquid celluloid in his work. One day he forgot to cork the bottle. Of course, the liquid evaporated and left a thin layer of celluloid, or something like it, on the inside of the glass bottle. He put the bottle aside and forgot about it until one day he accidentally knocked it from the shelf. It crashed to the ground, but instead of smashing to bits, it shattered, holding its shape. The hardened liquid held the cracked bits of glass in place. That gave him an idea and shortly after shatterproof glass was developed."

"But doesn't all glass of that kind get discolored after a time?" Kennedy inquired.

"Nope," Gus told him. "The seal I just told you about stops discoloration to a great extent and a new type of transparent filler sheet has been developed that's not affected by the sun's rays. Good shatter-proof glass will stay clear as long as it's intact."

"I don't doubt that safe glass is a wonderful thing," Kennedy agreed, "but it costs a lot of dough."

Gus shook his head. "But it's an investment, a safety investment," he pointed out. "Fifty percent of all the injuries in automobile accidents come from flying glass. Twenty or thirty bucks isn't much to spend to make your car fifty percent safer to ride in, is it? One good smash-up, when you have a car full of people, will cost you a lot more than that in doctor's bills alone.

"YOU'RE paying a doctor right now and accidents like yours can happen any time. Generally it won't be your fault, either."

"I guess you're right," said Kennedy after a pause. "Suppose you fix my car up with it. With children in the family, safety means something."

"Just the windshield?" Gus asked glancing at Kennedy.

"Not on your life!" Kennedy replied. "If I do it at all, I'll do it right. Put in safe glass all round."

"Fine!" said Gus as he wrote out the order. "Safety isn't something to buy in parts. Put it in front, back and sides and driving a car will be less of a worry to you."

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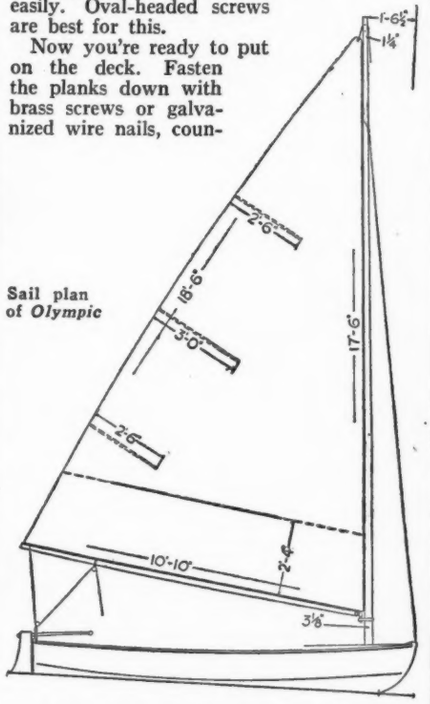
HERE IS THE LAST WORD IN RACING CATBOATS

(Continued from page 59)

The frames should be bent in after the planking has been secured. You can hold them in place by stepping on them while shoring them in at the chine. Fasten the frames to the keel and planking from the outside with copper nails, riveted over copper burs inside. Two to each plank will suffice.

Following this, lay the floor boards, preferably using ⅝ by 2½ in. spruce. Each board should be fastened with 1½-in. brass screws so they may be removed easily. Oval-headed screws are best for this.

Now you're ready to put on the deck. Fasten the planks down with brass screws or galvanized wire nails, countersinking them slightly to allow for putty.



Sail plan of *Olympic*

Follow the deck with the coaming, fastening it with screws to the carling and deck. This should be installed in three pieces, butted at the end of the round and with a small butt block inside the coaming. Oval-headed brass screws at 6-in. intervals should be used.

By this time you will realize how quickly *Olympic* may be built, for you are now ready to lay the canvas. This should be the 8-oz. grade. Stretch it dry, then lay it in marine glue. Smear the glue on generously and let the canvas, after being smoothed, drop 1½ in. over the side. Tack it down with ⅜-in. copper tacks. After turning up the edge, secure the canvas with a ½-in. quarter-round oak strip.

Except for rudder, sail, mast and boom, *Olympic* is complete. No instructions for making the rudder, sail, and boom are needed, other than to cut the rudder from a single piece of mahogany according to the drawings. Likewise, plane down the boom from a spruce pole to measure, finished, 10 ft. 10 in. long, 2 in. in diameter at the center, and 1¼ in. at the ends. The sail may be made from any material you select, preferably 6-oz. duck.

While I recommend a single-piece mast, which will weigh only 8 lb. more than the hollow mast used during the Olympic competition, you can build a hollow mast by grooving two spruce sections and joining them. For this purpose hand screws or clamps every 12 in. would be necessary—an expense probably not justified for private use. Otherwise, plane down the mast to measure 20 ft. 9½ in. from the top to the square piece fitting into the step.

Should you be interested in building a hollow mast, details are shown and can easily be followed.

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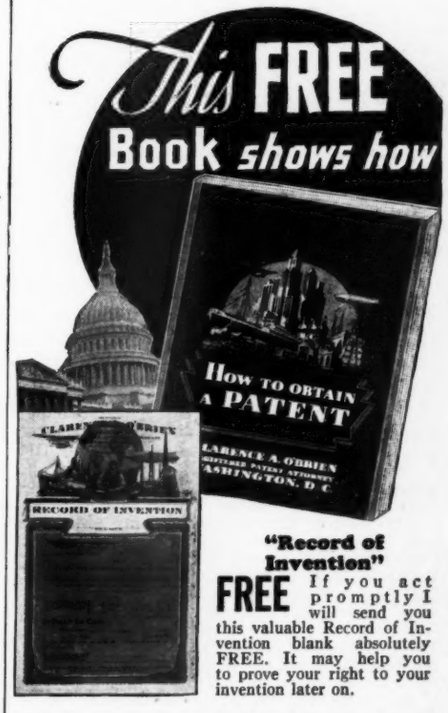

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SEEING STARLAND WITH AN OPERA GLASS

(Continued from page 41)

with lenses one and one-half inches in diameter or larger. Use it to find the object and see its general features. Then exchange the opera glass for a field glass of eight or greater power to examine the details.

Above and a little to the right of Antares, the opera glass will show you a wisp of light like a faint, formless star. This is a nebula—a whole universe in the making.

SWEEP your glass along the Scorpion's body and up to the two stars at the tip of his tail. Just above, and to the left of these two stars, you will find two more star clusters. In the field glass, you can see their structure—each a closely packed ball of suns, many of them much larger than ours.

Now sweep your glass from Scorpio's tail to the next group eastward, the Archer. In the upper part of the Archer, right on the planet's race course, you will spot two particularly fine star clusters, each composed of a multitude of little twinklers, none of which could be seen with the naked eye.

This whole region, where the Milky Way streams down across the ecliptic line, will repay a thorough searching with opera and field glass. You will discover many star groups and nebulae. Needless to say, this observing should be done on a clear, moonless night. The presence of a bright moon spoils everything when you're looking for faint objects with a field glass.

While on the subject of nebulae, we must mention the two grandest of all, although you must wait until next autumn and winter before you can observe them.

The first is in the constellation of Andromeda. The little map, inset in one of the illustrations accompanying this article, shows how to find it next November by a line from the polestar through the W of Cassiopeia.

The photograph of the nebula in Andromeda, was made with a powerful telescope. When seen without a glass, the faintness of its edges does not reveal its real size. It is actually about seven moon-breadths long and more than three wide.

The only other nebula that compares with it is the Great Nebula in Orion. This also can be found with the naked eye. Look for it next winter as the second of the three stars in the Sword of Orion, which hangs directly southward from his famous belt.

We have left until the last the object you might think would have been the first of all to attract our glass, the moon. It was the first of the heavenly bodies upon which Galileo turned his new telescope. He discovered that, instead of having a smooth, glassy surface, as everybody had supposed, the moon had high mountains and deep valleys. These are still the objects of unceasing study by the astronomers of today. Do not make the mistake of pointing your opera or field glass at the moon when it is full and round, or you will be disappointed. Choose rather a time when the disk is part dark and part light, and look along the line where dark and light join. This line is called the terminator. It is at this sunrise line on the moon that its mountains and craters appear most plainly.

THE best way to observe the moon with an opera glass is to begin when our satellite is a crescent in the west after sunset, and look at it every few evenings as the terminator advances across the surface. If you become familiar with the various features of the moon's geography as they appear successively on this line between dark and light, you will see them at their best and learn them easily, a few at a time. The three little maps reproduced show a few of the moon's thousands of features that have received names. Its surface has been mapped and named even more thoroughly than has that of the earth.

In choosing a glass, remember that most good field glasses bend in the middle. In other words, it is possible to adjust the distance between their eye lenses so that the field, as seen with both eyes, is circular. Few opera glasses have this means of adjustment, and sometimes, when the distance between the lenses does not fit your eyes, the two fields overlap, or fail to coincide, in a way that is both annoying and tiring. Any glass that shows a colored ring around objects is unfit for use.

IF YOU have an opera glass of which you do not know the magnifying power, you can determine it easily. Simply focus the glass on a brick wall fifty feet or so away. Then look through one barrel with one eye, while you look at the wall with the other eye unaided by the lenses. Then notice how many bricks, as seen by the naked eye, are required to equal in thickness one brick seen through the glass. This number is the magnifying power.

In the next article we shall present some interesting experiments using everyday materials to explain the sometimes erratic and puzzling movements of the planets and the moon along the race course of the sky. Among other things, these experiments show why planets sometimes seem to move backward in their paths and why Mercury and Venus are sometimes morning stars and sometimes evening stars.

THE prize of $10, offered for the best photograph of star trails made according to the directions given by Mr. Johnson in his article for April, has been awarded to John F. Cunningham, Conneaut, Ohio.

Star trail photos, submitted by the following, have been found worthy of honorable mention:

William J. Cahill, Woburn, Mass.; I. C. G. Cooper, Staten Island, N. Y.; Jack Davies, Syracuse, N. Y.; Warren A. Donaldson, Pittsburgh, Pa.; Norman Green, Hamilton, Ontario, Canada; Walter R. Hobbs, Jr., Columbus, Ohio; Russell Laitola, Ironwood, Mich.; Philip B. Mansfield, Buffalo, N. Y.; Lucile Parsons, Scranton, Pa.; Walter Schroeder, Omaha, Nebr.; W. Edward White, Plymouth, N. H.

ROBOTS THAT ANSWER PHONE RENTED OUT

ROBOTS that answer the 'phone are now rented out to subscribers in Vienna, Austria. When the subscriber has to leave his home or office for any length of time, he sets the apparatus to indicate the hour at which he will return. All calls are automatically taken by the device which indicates by strokes of a gong when the owner of the telephone will be back and can be reached by the calling party. In addition, the apparatus keeps a record of all the calls received.

SAWDUST CLEANS FURS

CLEANING furs with sawdust is an innovation tried out with success by furriers in New Zealand. They report that white pine sawdust is a valuable aid in dressing and cleaning furs. American fur-cleaning establishments are now testing the unusual idea.

OIL FIELDS FOUND BY MODERN MARVELS

(Continued from page 31)

cement has been set, where the fluid level is, and possibly, if there are any oil sands that in other days were overlooked.

This strange electrical stethoscope is but one of many scientific eyes that enable oil men to peer through two miles of rock. Other interesting devices include electrical cameras that make photographs of the interior of the hole, picturing the structure of formations; and instruments that release an electrical current into a stratum, pick it up again, and measure its strength as it flows back through the earth, thus analyzing the nature of the formation.

AIRPLANES, too, now aid the geologist. In the region of the Gulf of Mexico, occur many salt domes, where oil is held in a sort of great inverted tub, containing also a pool of salt water and a core of solid salt. Geologists frequently take to the air, studying not only the topography, but the color and appearance of the verdue.

A mottled color may mean that gas is escaping from myriads of infinitesimal leaks in a gas and oil formation, bleaching the soil and changing the appearance of the shrubbery. Sometimes, from the air, may be seen a large circular pattern in the undergrowth, shading off so gradually as to be invisible from the ground, yet from the air yielding a plain clue to hidden oil.

In probing for the salt dome, the temperature bomb is a new aid. It consists of a series of fusible alloy plugs, each with a different melting point. The lowest one in the scale, remaining unchanged in the well, represents the highest temperature below ground. Since it is usually hottest just above the salt plug, records of temperature gradients are useful clues.

Another help is the torsion balance—a pair of spring balances, so sensitive that they measure differences in the earth's attraction as slight as one part in a million. When it passes over a place where a heavy formation approaches the surface, a change is registered by the instrument, betraying a hidden dome.

Will radium prove a telltale clue to oil? One Texas geologist recommends testing cores from wildcat wells for radioactivity. Since oil has a strong absorbing power for radium emanations, he suggests that strong radioactivity may indicate the presence of nearby oil zones.

Sensitive chemical tests now detect the presence of good oil sands in cores that once would have been regarded as barren. If the oil zone contains heavy oil, the cores are dark brown or black, have a distinctive odor, and will stain the hands when handled. In some sands, oil can be detected by dissolving a little of the core in ether, chloroform, or carbon tetrachloride, which will turn yellow or brown if oil is present.

IN SOME of the richest fields, including the famous Kettleman Hills where the oil is almost pure gasoline and will run an automobile without refining, the cores are light gray in color, and have only a faint gasoline odor. Such cores are treated with acetone, which, if oil be present, turns slightly cloudy.

For years the prominent hills forming Gato Ridge, in California, tempted geologists. It was in a country surrounded by oil fields. Half a century ago, miners worked in the tar outcroppings, mining oil with pick and shovel. As the years passed, nine wildcat wells were drilled, each one a little deeper, as drilling science advanced, but all were abandoned as dry holes.

Recently, geologists made a further study of the region. A well was started, and from the time the drill began to bite through the grass roots, a core-bit was in place. Geologists sniffed the cores, studied them through microscopes, made test solutions in acetone.

Down to 6,200 feet went the bit. Then geologists ordered the well plugged back to 2,250 feet, and a production test was made. Oil flowed forth—1,000 barrels a day. Strangely, everyone of the wells drilled in past years had passed right through the producing formation. Unaided by modern chemistry, the drillers had not recognized the fortune within their grasp.

Oil from great pools under the ocean floor is an alluring possibility now under study by geologists. Near Ventura, Calif., a structure that was already producing was discovered to show a trend toward the ocean. Did the choicest part of the field life submerged beneath the sea?

To answer this question, geologists hired a tug to take them along the bay. Surveyors on the shore sighted each position of the tug through transits, triangulating its location and recording it upon a map. Clad in diver's suits, geologists trod the ocean bottom, inspecting outcroppings of formations. A high-pressure jet cleared away the surface sand, removing about a hundred square feet at each location and exposing bedrock.

WITH him, each geologist carried a Brunton compass, consisting of a magnetic compass and set of spirit levels, and filled with water to prevent bubbles. Placing the back of the compass against the tilted formations, they read the dip of each bed by the levels, just as if they were on dry land. Recording their observations and checking them with aerial photos, they discovered that the formation actually extended seaward.

A long pier was built out from the shore and a well drilled, striking a good producing formation. But geologists were not satisfied. Eager to test the structure farther at sea, where their observations indicate the best production will be obtained, they are now building an island of steel, founded on piling driven into the ocean floor. A pipeline will carry the oil ashore. Preliminary showings indicate that their deductions, based on this strange submarine geological work, are correct.

While making their deep-sea studies, geologists noted that the kelp beds seemed to follow the formations, being rooted in the sandy portions of the sea-bottom. From this fact, they hope in the future to be able to judge oil possibilities by study of aerial photos showing the distribution of kelp fields.

WIRE NETTING GUARDS TELEPHONE LINES

A WIRE-NETTING birdcage, an eighth of a mile long and twenty-four feet wide, now protects telephone lines running near the Columbia River, in Oregon, from flying rock. Long-distance wires were being sheared off by rocks blasted from a nearby quarry. The wire enclosure protects the lines and prevents interruption of the service.

RARE BEETLE IS FOUND IN TENNESSEE CAVE

ONE of the rarest beetles in the world is reported to have been found in a cave near Chattanooga, Tenn. It is said to be the first female of the species ever brought to light, the only other specimens known to have been found being two males which were taken from the Egyptian tomb of King Tut-ankh-amen.

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Tricks of Firebugs Exposed by Police Experts

(Continued from page 39)

some cases, they admitted taking gasoline from the fire engine to start fires. Frequently, they said, the motor of the engine would be running and the firemen would be in their places waiting for the alarm when it came in!

Pitt, one of the ace firebug fighters of the country, trapped one gang recently which had left a million-dollar trail of incendiary fires from Toronto, Can., to Long Island, N. Y. Last year, he obtained convictions for more than forty firebugs, in one instance pinning a $10,000 crime to a man through observing that a knot in an unburned fuse had been tied by a left-handed person.

Because an incendiary fire usually destroys the evidence of the crime, catching a torch wielder is one of the most difficult jobs a detective has to perform. The ruins are combed for the minutest clues. How tiny bits of evidence may put a sleuth on the trail of the criminal is illustrated in two recent examples.

IN A city in the Middle West, a man planned to burn his house for the insurance in a manner that would leave not the slightest clue behind. Near the foot of the cellar stairs, he placed a burning candle. At the top of the stairs, he filled a heavy cardboard hatbox with gasoline. The box extended over the edge of the top step so, when the fluid softened the pasteboard, the bottom would fall out on that side and the gasoline would rush down the stairs to be touched off by the flame of the candle. The time required for the pasteboard to soften gave him an opportunity to reach a place of safety.

The fire started as he had planned. But it ate its way so rapidly upward, it burned a bracing beam and permitted a wall to fall, burying the bottom steps before they burned. When the arson sleuth examined the cellar, he found the melted paraffin from the candle on a lower step. With this chance clue putting him on the trail, he traced the movements of the man and obtained his confession.

A few month ago, Sergeant Pitt turned over a brick in the basement of a home gutted by a suspicious fire. Under it, he saw the remains of a small pack of matches, the heads burned off and the stub of a cigarette wedged in among them. A fine line of ashes ran to either side. The ashes represented a fuse that had been strung through the matches before the cigarette was inserted among them. Then the cigarette had been lighted, burning slowly and giving the firebug time to escape before it touched off the matches which, in turn, lighted the fuse that carried the fire to tinder placed at strategic points about the house. The chance falling of a brick had preserved this evidence, exposing the plot.

MOST incendiary fires are started by means of time devices that give the crook time to get away and establish an alibi by being somewhere else when the fire starts.

In one case, a handful of matches was fastened around a lighted cigar by means of a rubber band. When the tobacco burned down to the match-heads, the flame touched off a pile of papers sprinkled with gasoline. In another instance, a stick of chemical was placed at the bottom of a large tin can filled with water. A pin-hole in the bottom of the container permitted the water to drip gradually away. Two days later, when the last of the water had run from the can, the reaction between the oxygen in the air and the chemical caused the latter to burst into flame and ignite a jar of gasoline.

Candles, which burn at the rate of an inch an hour, are sometimes placed in huge boxes of excelsior so when the candle burns low, flame will reach the tinder at a certain hour of the night. In several incendiary fires, a fuse was threaded through a hole near the bottom of a candle to carry the fire to piles of tinder when the candle burned down after an elapse of several hours.

The most elaborate set-up of this kind was prepared by an eastern firebug. A quickmatch fuse, the fastest burning kind, was inserted in a candle and then run from one to another of forty-two waxed-paper containers. Each held a quart of gasoline. This string of containers extended through every room from the cellar to the garret. In addition, the owner pried up floorboards and stuffed gasoline-soaked rags beneath. He inserted a penknife between the laths in the wall and poured in gasoline. And, after the fire, a detective found that an overcoat, discovered beneath eighteen inches of water in the basement, still retained nearly half a pint of gasoline.

Just as the first container burst into flame, a neighbor drove into his yard. He had been delayed by tire trouble in returning from a late show. He saw the fire and telephoned in an alarm. In less than five minutes, the fire engines were at the door pouring water into the interior of the dwelling. Under this deluge, the flames died out leaving a score of the containers intact. Through their mute testimony, the plotter was convicted and sentenced to prison.

Sometimes a detective, trailing firebugs, has to let them actually start a fire in order to obtain the evidence necessary to put them behind the bars. In such cases, all the preparations are made beforehand for split-second work in extinguishing the flames.

A classic example is the manner in which Brophy wiped out an arson ring in Brooklyn some years ago. To catch the firebugs red-handed, he let them start a fire in a building where nine innocent persons were sleeping. But, he had all his preparations ready. Chemical extinguishers and 300 feet of inch-and-a-half fire hose were secreted in a peddler's wagon under its load of onions, potatoes, cabbage, string beans, and cauliflower. Street cleaners in the neighborhood were crack firefighters in disguise and other members of the fire department were hidden away in nearby buildings.

Brophy was watching a window on the upper floor where he knew the gang was at work. There was a puff of smoke. A moment later, two firebugs dashed out of the front door of the building. Brophy, with a right to the jaw, knocked one out while a fireman nailed the other in a flying tackle.

VEGETABLES poured into the street as the hose and extinguishers were dragged from the wagon. A feverish few minutes followed. But when they were over, the blaze was out, the residents of the house were safe, and the prisoners were on their way to jail and, later, to fifteen years in Sing Sing.

The motives for arson, outside of the urge that drives on the unbalanced pyromaniac, I was told, are fraud, revenge, and an effort to cover up a murder or other crime by destroying the evidence. Fires for fraud far outnumber the others.

Plant Growth and Yield Speeded in Midget Gardens

(Continued from page 35)

decreasing the number of hours of light a plant receives each day. Thus, radishes have been prevented from going to seed when spring gives way to summer, and have been kept in an edible condition for over a year. These light-effect studies may lead to profitable means of growing out-of-season fruits and vegetables—which is but another form of concentrated or accelerated gardening.

ALTHOUGH not gardening in a strict sense, a method of injecting new life into old orchards, described by the late Luther Burbank, makes it possible to save years of time in growing things for money. Burbank pointed out several cases where a fruit grower purchased an old, run-down orchard for almost nothing, and then cleaned it up by pruning trees, removing underbrush, cultivating the ground around the trees, adding fertilizer, growing clover or some other beneficial crop around trees for eventual plowing under, and finally by grafting new stock on old trees.

A method of hastening the ripening of fruit has been used by large growers and wholesalers for some time, and is rapidly gaining in popularity. This is the treating of nearly-ripe fruit with ethylene gas. The process can be adopted by the small-time gardener who desires early vegetables and fruit, or who wishes to dispose of a portion of his crop at maximum profit. Cost of equipment for this ripening process is low.

The art of fruit-ripening, now being revived, was developed by Chinese and Arabs centuries ago. Not many years back, growers of oranges and other products were using kerosene lamps and lanterns to speed the ripening of fruit. Later it was found that the active agent in kerosene fumes was ethylene, a hydrocarbon that is found in illuminating gas. Today, bottled ethylene is used.

Gassed fruit is, in many cases, superior to tree-ripened products. It often has a better color, is sweeter, better flavored, and it can be produced more quickly. Green fruit can be shipped great distances without bruising, and then ripened to meet market requirements at the point of consumption.

ETHYLENE gas is about as explosive as natural gas or acetylene. However, it is released into a room in such low concentration, one part to 1,000 of air, that there is little danger. The tank itself must be kept cool and not dropped, and no open fire can safely be placed near it. Usually the tank is taken into the ripening room just long enough to release the required amount of gas. Then it is removed. A few minutes later, after the gas has diffused through the room, an open flame will not cause an explosion. There is no affect on breathing. The best fruit-ripening concentration of ethylene gas is one to 1,000, it takes a three percent concentration, or thirty times as much, to make an explosive mixture.

FRUITS and vegetables that have been ripened in large lots by the gas include tomatoes, bananas of all kinds, pineapples, celery, cantaloupes, limes, lemons, oranges, and grapefruit. Promising results have been obtained with pears, dates, jujubes, mangoes, peppers, alligator pears, pomegranates, apples, honeydew melons, papayas, plums, chayotes, custard apples, rhubarb, endive, chicory, and plantains.

Unfavorable results were obtained with asparagus, cauliflower, watermelons, and other products that have thick rinds and contain little hydrocarbonate reserves. Ethylene also has been suggested for fruits and vegetables from which tannins, chlorophyll, organic acids, and other bitter substances are to be removed. The gas can be used in converting starch in fruits into sugar.